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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

TECHNICAL NOTE

No. 950

NUMERICAL PROCEDURES FOR THE CALCULATION OF THE STRESSES IN MONOCOQUES

II — DIFFUSION OF TENSILE STRINGER LOADS IN REINFORCED FLAT PANELS WITH CUT-OUTS

By N. J. Hoff and Joseph Kempner
Polytechnic Institute of Brooklyn

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SUMMARY

Experiments were carried out at the Polytechnic Institute of Brooklyn with a flat reinforced sheet model the longitudinals of which were loaded axially. In the first group of tests one panel of sheet, and in the second group two panels of sheet and the intervening portion of a stringer, were cut out. The stress distribution in stringers and sheet was measured with electric strain gages. The stresses were then calculated with the aid of a procedure of successive approximations similar to the one presented in NACA TN No. 934 (reference 1). The agreement between calculations and experiment was found to be reasonably good.

INTRODUCTION

The methods of and the formulas used in the analysis of monocoque aircraft structures have been developed almost invariably for cylinders of circular, or possibly elliptic, cross section and of uniform mechanical properties. Yet in actual aircraft such structural elements are seldom, if ever, found. Unfortunately, the direct methods of analysis are little suited to cope with the problems involving complex cross-sectional shapes, irregular distribution of reinforcing elements, concentrated loads, and cut-outs. It is believed that the indirect methods recently advanced by Hardy Cross, and particularly by R. V. Southwell, (references 2 and 3) promise a solution of such problems.

In this indirect approach the stress distribution in a structure under specified loads is determined through step-by-step approximations. In each step the state of distortion of the structure is arbitrarily modified and the stresses corresponding to the distortions are calculated. The procedure must be continued until the stresses and the external loads over the entire structure are in equilibrium. When the steps are undertaken at random, the procedure is likely to lead to a solution only, if ever, after a very great number of steps. If the calculations are to be well convergent – that is, if a reasonably rapid approach to the final state of distortion is to be attained – the steps must be undertaken according to suitable predetermined patterns. This is the reason Southwell called the procedure the Method of Systematic Relaxations.

It is the object of the present investigations to develop patterns which make a solution possible, with engineering accuracy, through a limited number of steps. This end is approached by means of theoretical considerations, strain measurements, and comparative calculations. The immediate goal is to work out a procedure which permits the solution of the complex problems previously mentioned, even though approximate results are all that may be attained for the time being.

The procedure can be refined so that it will give more accurate results. It is planned to carry out this development after the more immediate problems are solved.

In this second report experiments are described which were performed in the Aircraft Structures Laboratory of the Polytechnic Institute of Brooklyn with two flat sheet-stringer combinations each having a cut-out. The stress distribution under concentrated loads was investigated with the aid of Baldwin-Southwark Metalectric strain gages. Displacement patterns were developed for the step-by-step procedure the use of which permits a rapid convergence of the computations. The results of the calculations were in reasonably good agreement with the tests.

This investigation, conducted at the Polytechnic Institute of Brooklyn, was sponsored by and conducted with the financial assistance of the National Advisory Committee for Aeronautics. For his aid in the tests and the calculations credit is due Ivan P. Villalba.

SYMBOLS

b distance between adjacent longitudinals

h distance between adjacent transverse reinforcements

t thickness of sheet

u horizontal displacement

u_{block} horizontal block displacement

u_N horizontal displacement of point N

$u_{n\ tot}$ total horizontal displacement of point N

v vertical displacement

v_{block} vertical block displacement

v_N vertical displacement of point N

$v_{n\ tot}$ total vertical displacement of point N

x, y corrdinates

$\widehat{xx}_{MN}$ influence coefficient signifying a force in the x-direction at the point M due to a unit X displacement of point N

$\widehat{xy}_{MN}$ influence coefficient signifying a force in the x-direction at point M due to a unit y displacement of point N

$\widehat{yy}_{MN}$ influence coefficient signifying a force in the y-direction at point M due to a unit y displacement of point N

$\widehat{yx}_{MN}$ influence coefficient signifying a force in the y-direction at point M due to a unit x displacement of point N

A_{tot} total effective cross-sectional area of a stringer

A–Q symbols used to designate points of intersection of longitudinal and transverse reinforcements

B, M, T symbols used to designate bottom, middle, and top horizontal sections, respectively, of model

B' location of point B after displacement

E modulus of elasticity

G modulus of elasticity in shear

K numerical constant

L length

L_{MN} distance between points M and N

σ_x direct stress in horizontal reinforcing strip

σ_y direct stress in vertical reinforcing strip

1 – 36 symbols used to designate strain gages

I – IV symbols used to designate stringers

EXPERIMENTAL INVESTIGATIONS

The test model shown in figure 1 consisted of a flat sheet of 24 S-T aluminum alloy reinforced with longitudinally and transversely arranged steel strips. The model was the one used for the experiments described in reference 1, but for the first group of the present tests one panel of sheet, for the second group of tests two panels of sheet and the intervening portion of a stringer, were removed. The resulting structures will be referred to as "model with single cut-out," and "model with double cut-out," respectively.

The test apparatus was the same as that used for the experiments described in reference 1. Equal tensile forces applied at the four bottom stringer extensions were balanced by equal tensile forces at the two top stringer extensions. The double cut-out condition of the model is shown in the photographs of figures 2 and 3. Two angle irons were used to prevent the lower edge of the cut-out from buckling. These acted like the lugs described in reference 1 which supported the upper edge of the model. A lubricated sliding contact between a fitting at the end of the angle irons and the lower edge of the cut-out prevented restraint in the plane of the sheet.

Loads and strains were measured with Baldwin-Southwark Metalectric strain gages. No details of the measuring technique need be given here since the procedure followed was the same as that described in reference 1. The square of aluminum and steel to which the dummy gages were cemented is clearly visible in figure 2. Tests were performed on the model with single cut-out at load increments of 240 and 496 pounds, and on the model with double cut-out at load increments of 248 and 492 pounds. A tare load of 240 pounds was used for all tests. Since the stresses obtained for the higher load conditions were practically double those of the lower, the lower load condition only was used for comparison of experimental and calculated stresses.

The experimental data were analyzed in the same manner as in reference 1. For all stress calculations the modulus of elasticity was taken as 30×10^6 psi and 10.3×10^6 psi for steel and aluminum, respectively.

The total effective width of sheet for both model conditions was taken as that obtained for the flat sheet in reference 1: namely, 6.72 inches. As was done previously the overlapped portions of the sheet at the central stringers were assumed fully effective in carrying normal stresses. Consequently, the average total effective area of a vertical or horizontal edge stringer was found to be 0.1301 square inch, that of a central vertical stringer 0.1418 square inch, and that of a central horizontal strip 0.1381 square inch. For the stringers adjacent to the cut-out these values were necessarily modified to 0.1256 and 0.1337 square inch for segments HM and GL, respectively (see fig. 7) and to 0.1301 square inch for strips GH and LM, because of the absence of panel GHML. Similar changes also were made when the model with the double cut-out was considered. The values for FK, FG, and KL (see fig. 8) became 0.1337, 0.1301, and 0.1301 square inch, respectively. It should be noted that the areas of effective width of the aluminum sheet had been converted into equivalent areas of steel.

The values given in the preceding paragraph will be used later for the calculation of the influence coefficients needed for the relaxation procedure.

DERIVATION OF THE FORMULAS USED IN THE SUCCESSIVE APPROXIMATIONS PROCEDURE

As in reference 1, the unit of the elastic structure considered in this paper consists of a panel of sheet metal and the four segments of bars fastened to its edges (fig. 4). It is assumed that the bars are attached to one another by ideal pins and that they have infinite rigidity in bending. In reference 1 only the forces acting in the vertical (y) direction were taken into account. Consideration of the horizontal forces was unnecessary because of the symmetry of the structure and loading about a vertical axis. In the present investigations, the loads are still applied symmetrically, but the symmetry of the structure is destroyed by the cut-outs. Consequently, it is necessary to calculate the equilibrium of the horizontal forces acting in the structure, and thus two more types of influence coefficients must be developed in addition to the $\widehat{yy}$ influence coefficients derived in reference 1.

It follows from the derivations presented in reference 1 that the $\widehat{yy}$ influence coefficients pertaining to point B of figure 4a - that is, the vertical forces transmitted to the constraints at points A, B, C, and D when point B is moved through a unit distance in the positive y direction - can be given by the following equations:

$$\begin{aligned} \widehat{yy}_{AB} &= \widehat{yy}_{DB} = Gth/4b \\ \widehat{yy}_{CB} &= EA_{tot}/h - Gth/4b \qquad (1) \\ \widehat{yy}_{BB} &= -(EA_{tot}/h + Gth/4b) \end{aligned}$$

It is obvious that a horizontal force arising from a unit horizontal displacement is analogous to a vertical force arising from a unit vertical displacement. Consequently, if point B in figure 4 is displaced through a unit distance in the positive x-direction, the following influence coefficients apply:

$$\begin{aligned} \widehat{xx}_{AB} &= (EA_{tot}/b - Gtb/4h) \\ \widehat{xx}_{CB} &= \widehat{xx}_{DB} = Gtb/4h \qquad (2) \\ \widehat{xx}_{BB} &= -(EA_{tot}/b + Gtb/4h) \end{aligned}$$

It should be noted that the quantities $Gtb/4h$ and $Gth/4b$ are unit forces caused by the resistance of the sheet to shearing deformations. By the law of the complementary shearing stress, however, horizontal displacements also must give rise to vertical shearing forces, and vertical displacements to horizontal shearing forces. Consequently, there are couplings between quantities pertaining to the vertical and the horizontal directions which can be expressed by $\widehat{xy}$ and $\widehat{yx}$ influence coeficients. Those corresponding to a displacement of point B as shown in figure 4b are given by the following equations:

$$\begin{aligned} \widehat{yx}_{CB} &= \widehat{yx}_{BB} = Gt/4 \\ \widehat{yx}_{AB} &= \widehat{yx}_{DB} = -Gt/4 \end{aligned} \tag{3}$$

Similarly, through the consideration of the effects of a unit vertical displacement of point B the following formulas can be derived:

$$\begin{aligned} \widehat{xy}_{CB} &= \widehat{xy}_{DB} = -Gt/4 \\ \widehat{xy}_{AB} &= \widehat{xy}_{BB} = Gt/4 \end{aligned} \tag{4}$$

When the structure consists of several panels as in figure 5, the effect of all of them must be taken into account simultaneously. Therefore, the following influence coefficients can be calculated through consideration of the displacements of point A:

$$\begin{aligned} \widehat{xx}_{BA} &= \widehat{xx}_{DA} = \widehat{xx}_{HA} = \widehat{xx}_{FA} = Gtb/4h \\ \widehat{xx}_{CA} &= \widehat{xx}_{GA} = Gtb/2h \\ \widehat{xx}_{EA} &= \widehat{xx}_{IA} = (EA_{tot}/b - Gtb/2h) \\ \widehat{xx}_{AA} &= -(2EA_{tot}/b + Gtb/h) \\ \widehat{yx}_{BA} &= \widehat{yx}_{FA} = Gt/4 \\ \widehat{yx}_{DA} &= \widehat{yx}_{HA} = -Gt/4 \end{aligned} \tag{5}$$

$$\widehat{yy}_{BA} = \widehat{yy}_{DA} = \widehat{yy}_{FA} = \widehat{yy}_{HA} = Gth/4b$$
$$\widehat{yy}_{IA} = \widehat{yy}_{EA} = Gth/2b$$
$$\widehat{yy}_{CA} = \widehat{yy}_{GA} = (EA_{tot}/h - Gth/2b) \tag{6}$$
$$\widehat{yy}_{AA} = -(2EA_{tot}/h + Gth/b)$$
$$\widehat{xy}_{BA} = \widehat{xy}_{FA} = Gt/4$$
$$\widehat{xy}_{DA} = \widehat{xy}_{HA} = -Gt/4$$

Influence coefficients which do not appear in the foregoing equations are equal to zero. It should be noted that the following relations exist between influence coefficients:

$$\widehat{xx}_{MN} = \widehat{xx}_{NM}$$
$$\widehat{yy}_{MN} = \widehat{yy}_{NM} \tag{7}$$
$$\widehat{xy}_{MN} = \widehat{yx}_{NM}$$

These equations follow from Maxwell's reciprocal theorem. They may be easily verified with the aid of the formulas given above.

The operations table and relaxation table are set up in a manner similar to that described in reference 1. The normal stress in a segment of a horizontal or vertical strip between points M and N, and P and Q is, respectively,

$$\sigma_x = (u_N - u_M)E/L_{MN}$$
$$\sigma_y = (v_P - v_Q)E/L_{PQ} \tag{8}$$

APPLICATION OF THE RELAXATION PROCEDURE

TO A MODEL WITH CUT-OUT

The procedure adopted for the calculation of the stress distribution in the reinforced panel with a cut-out was as follows:

First the complete structure (without the cut-out) was balanced. Then the unbalanced forces were determined corresponding to the displacements of the complete structure and to the influence coefficients of the model with the single cut-out. These unbalanced forces were reduced in the third step to negligible quantities through a number of relaxations. The displacement pattern thus obtained was used for a first approximation to the distortions of the model with the double cut-out. The unbalanced forces corresponding to this pattern and to the influence coefficients of the model with the double cut-out were calculated and reduced through relaxations to negligibly small values.

The procedure was found to be rapidly convergent since the cut-outs materially affected the displacements and stresses only in their immediate neighborhood. The double cut-out condition could have been calculated directly from the complete structure, but the intermediate case of the model with the single cut-out was needed for the purpose of comparison with test results.

In figures 6 to 8 schematic drawings of the three model conditions investigated are shown. Table 1 contains the influence coefficients $\widehat{yy}$, $\widehat{xx}$, and $\widehat{xy}$ for the model in its three different conditions. The table proper was calculated for the complete model. The first auxiliary table (starred values) gives all those influence coefficients which changed because of the single cut-out. The second auxiliary table contains the influence coefficients the values of which (marked with a dagger) changed when the single cut-out was transformed into the double cut-out. Because of equations (7) only one-half of the total number of the influence coefficients had to be listed.

Table 2 is the Operations Table. It contains individual and block displacements calculated in the same manner as described in reference 1. Several of the boxes in this table contain two figures. The upper figure pertains to the model with the single cut-out; while the lower figure holds for the model without a cut-out. Where only one value appears in a box, it applies to both conditions of the model.

Since both the model and its loading are symmetric, symmetrically situated points must displace symmetrically. This means that vertical displacements of symmetrically situated points are equal in both magnitude and sense; while their horizontal displacements are equal in magnitude and opposite in sense. Because of these symmetry properties the group operations listed in table 3 are found convenient for the numerical work of relaxation.

In the first line of the Relaxation Table (table 4) the external loads are entered. With the aid of the group operations of table 3 the unbalanced vertical forces are reduced to negligible quantities in comparatively few steps. Details of the procedure followed are not explained here, since they were described in reference 1. However, after these relaxations have been completed, residual forces which are not considered negligible exist in the horizontal direction. The structure must be relaxed, therefore, until the horizontal forces are reduced to negligibly small quantities. Before this is done, however, the total displacement given to each point is obtained and used as a check on previous work (table 5). It may be seen that the residual forces in the check table differ slightly from those obtained before. Since they define the present state of equilibrium more accurately than do the previous residual forces, relaxation should be continued from the values listed in the check table.

Because of the symmetry of model and loading, the horizontal residual forces just obtained are also symmetric. As the uppermost horizontal contains the points at which the greatest unbalances occur, the forces there are reduced first. It may be seen that a simultaneous displacement of points A and D toward the axis of symmetry of the model, followed by a similar simultaneous displacement of points B and C, reduces the unbalances considerably (table 6). After these operations have been carried out twice in succession, negligible residual forces remain. Since the unbalances on the other horizontals are of the same nature, steps similar to those just undertaken reduce all remaining unbalances to small quantities. The advantage of reducing the large unbalances of the top horizontal first is almost self-evident. Large unbalanced forces require proportionately large displacements in the relaxation procedure; consequently, forces which are not negligible are thrown on the points of the adjacent horizontal when the top horizontal is relaxed. However, when the smaller unbalanced forces of the other horizontals are reduced, the forces transmitted to the top horizontal are negligibly small. As a matter of fact, in the present calculations these forces were fractions of the unit used in the table and were, therefore, not listed.

Since the effect of the relaxations undertaken in table 6 upon the forces in the vertical direction is negligible, no further relaxations are necessary. However, a check is made in order to ascertain the accuracy with which the horizontal relaxations have been performed. The residual forces present before the horizontal relaxations are entered in the top row of the Check Table (table 7). No additional vertical displacements were undertaken after the first check; therefore, a check involving only horizontal displacements suffices. The final vertical and horizontal residual forces are given in the last row of the table. As these forces are negligibly small, the relaxation of the model without a cut-out is considered to be completed. With the aid of equations (8) and the total displacements from tables 5 and 7 the stresses in all segments of the verticals and the horizontals may be calculated. The calculations are presented in table 8. It should be noted that $E/L_{MN} = 30 \times 10^6/8 = 375 \times 10^4$ psi per inch for each segment.

The stresses in the verticals are found to be the same as those obtained in reference 1. This verifies the assumption of reference 1 that the effect of the horizontal displacements upon the stresses in the vertical direction is small in the symmetric model. The stress distribution in the horizontals is given in figure 12.

The problem of the model with the single cut-out now may be attacked. The numerical work is facilitated by the use of the Group Operational Table (table 9) prepared with the aid of table 1. As a first approximation the deflections obtained for the model without a cut-out were assumed to be also the deflections of the model with the single cut-out. The magnitude of the error made can be judged if the unbalanced forces are calculated from these deflections with the aid of the values pertaining to the model with the single cut-out listed in table 2 (Operations Table). These calculations are contained in table 10, which has the title "Check Table of Relaxations for Model without Cut-Out with Operations Pertaining to Model with Single Cut-Out." The forces are in equilibrium at all joints except those in the immediate vicinity of the cut-out, as was to be expected.

Unbalance exists in both the vertical and the horizontal directions at points G, H. L, and M. With this condition as a starting point the model can be readily relaxed.

As before, the unbalanced vertical forces are reduced first. Stringer segment MQ is displaced as a unit (table 11). This step is followed by a displacement of segment DH. The steps are repeated in the same sequence until a state is reached at which individual displacement of the points appear to be advantageous. Finally, a block displacement of stringer IV reduces the vertical residual forces to the magnitudes desired.

The total displacement given to each point is found and is tabulated in table 12. The residual forces obtained in this table now must be considered. They are small in the vertical direction and comparatively large in the horizontal direction. In accordance with the pattern established in reference 1, through suitable operations the unbalanced forces are distributed in such a manner that simultaneous block displacements of the horizontals ABCD and JKLM result in reducing the forces considerably (table 13). A few additional individual displacements followed by a vertical group displacement of the edge stringer DHMQ reduce the unbalanced forces to small quantities. Because the solution of the model with the single cut-out depends on the previous solution of the complete model, a check table which takes into account the total displacements of each point is given in table 14. These displacements are obtained by adding the displacement of each point in table 10 to the displacement of the same point in tables 12 and 13. Since a few of the residual forces are slightly larger than desirable, small adjustments are made in the total displacements of four points. The starred values at the end of the table are the adjusted values of the corresponding starred values in the table proper. At this stage of the procedure the adjustments were found to be the most convenient means of balancing the residual forces. The final residual forces appear in the last line of the table.

In table 15 the stress calculations are presented for the model with the single cut-out. A comparison of the experimental and the calculated normal stress in the stringers is given in figure 9. The dotted lines in figure 12 represent the normal stresses in the horizontals.

With the solution of the problem of the model with the single cut-out now available, the problem of the model with the double cut-out can be solved in a manner similar to that just described. The Operations Table for Model with Double Cut-Out (table 16) is established from the pertinent values of table 1. With this operations table the Check Table of Relaxations for Model with Single Cut-Out with Operations Pertaining to Model with Double Cut-Out (table 17) is calculated from the displacements listed in table 14. The residual forces are entered in the first row of the relaxation table (table 18). A displacement of point G, followed by a rigid body displacement of stringer segment CG, reduces the large unbalanced force at G considerably. Similar operations reduced the force at L. Several individual displacements are then taken, resulting in residual forces which are negligibly small at most of the remaining points also. A rigid body displacement of stringer segment DH is found helpful in this process. The unbalances in the horizontal direction are distributed by displacements of individual points preparatory to a horizontal group displacement of the three upper fields, which in turn reduces the residual forces considerably. A few individual point displacements then suffice to attain unbalanced forces in the horizontal direction which can be considered negligibly small. In this process, however, relatively large vertical forces are introduced at several joints. A group displacement of stringer I, followed by simultaneous displacements of points A, B, N, and O, reduce these remaining forces to small values. The Complete Check Table for Model with Double Cut-Out is presented in table 19 in which the total displacements of the joints are listed as computed from tables 17 and 18. Minor adjustments again are made in the displacements. They are listed at the end of the table.

The stress calculations are given in table 20. A comparison of the experimental and the calculated direct stress in the stringers is contained in figure 10. The dot-dash lines in figure 12 represent the direct stress in the horizontal strips. The variation of the calculated direct stress in the stringers with the changes made in the original model is shown in figure 11.

In conclusion, it may be stated that, in general, the agreement between calculated and measured stress is reasonably good. In the case of the model with the single cut-out the measured and the calculated stresses almost exactly coincide in the graphs along stringers I, III, and IV. The agreement is almost equally good along stringers II and IV and in the upper portion of stringer III, in the model with the double cut-out. In this model, however, the stress measured in stringer I is consistently less than that calculated. The probable reason is an underestimation of the load-carrying capacity of the sheet, especially in the upper portion of the model. Similarly, the rough assumption of a uniform effective width all over the model might be responsible for the disagreement between experiment and calculation in the neighborhood of the concentrated load applied to the discontinuous stringer.

CONCLUSIONS

In this second report on numerical procedures for the calculation of the stresses in monocoques tests are described which were carried out at the Polytechnic Institute of Brooklyn in order to establish the stress distribution in sheet and stringer combinations loaded with concentrated loads applied to the stringers. In the first test model there was a cut-out involving one panel of sheet, and in the second model one involving two panels of sheet and the intervening portion of a stringer. The stresses also were determined analytically by a step-by-step approximation procedure. The agreement was reasonably good between the results of the calculations and the experiments.

The suggestions made in the conclusions of the first report (reference 1) regarding details of the numerical procedure again were found to result in a rapid convergence of the calculations. Moreover, it was found that the following approach is advantageous if there is a cut-out in the sheet and stringer combination:

(1) Calculate the stresses as if the structure were complete (using influence coefficients pertaining to the structure without the cut-out).

(2) Consider the displacement pattern obtained as a first approximation to the actual displacements of the structure with a cut-out. Determine the unbalanced forces corresponding to these displacements, using the actual values of the influence coefficients in the structure with the cut-out. Reduce these unbalanced forces through a suitable series of relaxations, preferably following the recommendations presented in the Conclusions of reference 1.

It is believed that this procedure will result in a fairly rapid determination of the stress distribution in sheet and stringer combinations in which the end points of the reinforcing strips are free to move, provided the cut-out is not disproportionately large.

Polytechnic Institute of Brooklyn,
Brooklyn, New York, July 1944.

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TABLE I. INFLUENCE COEFFICIENTS FOR THE THREE CONDITIONS OF THE MODEL. SHEET 1.

VALUES FOR MODEL WITHOUT CUTOUT.

nm	$\widehat{yy}_{nm}$ $\times 10^{-4}$	$\widehat{xx}_{nm}$ $\times 10^{-4}$	nm	$\widehat{yy}_{nm}$ $\times 10^{-4}$	$\widehat{xx}_{nm}$ $\times 10^{-4}$	nm	$\widehat{yy}_{nm}$ $\times 10^{-4}$	$\widehat{xx}_{nm}$ $\times 10^{-4}$
AB	2.00	46.8	EJ	46.8	2.00	JO	2.00	2.00
AE	46.8	2.00	EK	2.00	2.00	† KL	4.00	47.8
AF	2.00	2.00	† FG	4.00	47.8	KN	2.00	2.00
BC	2.00	46.8	FJ	2.00	2.00	KO	49.2	4.00
BE	2.00	2.00	† FK	49.2	4.00	KP	2.00	2.00
BF	49.2	4.00	† FL	2.00	2.00	* LM	4.00	47.8
BG	2.00	2.00	* GH	4.00	47.8	LO	2.00	2.00
CD	2.00	46.8	† GK	2.00	2.00	LP	49.2	4.00
CF	2.00	2.00	*† GL	49.2	4.00	LQ	2.00	2.00
CG	49.2	4.00	* GM	2.00	2.00	MP	2.00	2.00
CH	2.00	2.00	* HL	2.00	2.00	MQ	46.8	2.00
DG	2.00	2.00	* HM	46.8	2.00	NO	2.00	46.8
DH	46.8	2.00	JK	4.00	47.8	OP	2.00	46.8
EF	4.00	47.8	JN	46.8	2.00	PQ	2.00	46.8

* VALUES FOR SINGLE PANEL CUTOUT.

GH	2.00	46.8	GM	0	0	HM	47.1	0
GL	48.1	2.00	HL	0	0	LM	2.00	46.8

† VALUES FOR DOUBLE PANEL CUTOUT.

FG	2.00	46.8	FL	0	0	GL	0	0
FK	48.1	2.00	GK	0	0	KL	2.00	46.8

TABLE I. INFLUENCE COEFFICIENTS FOR THE THREE CONDITIONS OF THE MODEL. SHEET 2.

VALUES FOR MODEL WITHOUT CUTOUT.

nm	$\widehat{xy}_{nm}$ $\times 10^{-4}$	nm	$\widehat{xy}_{nm}$ $\times 10^{-4}$	nm	$\widehat{xy}_{nm}$ $\times 10^{-4}$	nm	$\widehat{xy}_{nm}$ $\times 10^{-4}$	nm	$\widehat{xy}_{nm}$ $\times 10^{-4}$	nm	$\widehat{xy}_{nm}$ $\times 10^{-4}$
AB	2.00	BA	-2.00	EJ	-2.00	JE	2.00	JO	2.00	OJ	2.00
AE	-2.00	EA	2.00	EK	2.00	KE	2.00	†KL	0	†LK	0
AF	2.00	FA	2.00	†FG	0	†GF	0	KN	-2.00	NK	-2.00
BC	2.00	CB	-2.00	FJ	-2.00	JF	-2.00	KO	0	OK	0
BE	-2.00	EB	-2.00	†FK	0	†KF	0	KP	2.00	PK	2.00
BF	0	FB	0	†FL	2.00	†LF	2.00	*LM	0	*ML	0
BG	2.00	GB	2.00	*GH	0	*HG	0	LO	-2.00	OL	-2.00
CD	2.00	DC	-2.00	†GK	-2.00	†KG	-2.00	LP	0	PL	0
CF	-2.00	FC	-2.00	*†GL	0	*†LG	0	LQ	2.00	QL	2.00
CG	0	GC	0	*GM	2.00	*MG	2.00	MP	-2.00	PM	-2.00
CH	2.00	HC	2.00	*HL	-2.00	*LH	-2.00	MQ	2.00	QM	-2.00
DG	-2.00	GD	-2.00	*HM	2.00	*MH	-2.00	NO	-2.00	ON	2.00
DH	2.00	HD	-2.00	JK	0	KJ	0	OP	-2.00	PO	2.00
EF	0	FE	0	JN	-2.00	NJ	2.00	PQ	-2.00	QP	2.00

* VALUES FOR SINGLE PANEL CUTOUT.

GH	-2.00	HG	2.00	GL	2.00	LG	-2.00	GM	0	MG	0
HL	0	LH	0	HM	0	MH	0	LM	2.00	ML	-2.00

† VALUES FOR DOUBLE PANEL CUTOUT.

FG	-2.00	GF	2.00	FK	2.00	KF	-2.00	FL	0	LF	0
GK	0	KG	0	GL	0	LG	0	KL	2.00	LK	-2.00

TABLE 2. OPERATIONS TABLE FOR MODEL WITHOUT CUTOUT AND WITH SINGLE CUTOUT. SHEET I.

(WHERE TWO FIGURES APPEAR IN A BOX, THE LOWER PERTAINS TO THE FORMER CONDITION, THE UPPER TO THE LATTER CONDITION.)

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
$V_A = 1$	$\underline{50.8}$	2.00			46.8	2.00											$\underline{2.00}$	$\underline{2.00}$			2.00	2.00										
$V_E = 1$	46.8	2.00			$\underline{101.6}$	4.00			46.8	2.00							$\underline{2.00}$	$\underline{2.00}$			0	0			2.00	2.00						
$V_J = 1$					46.8	2.00			$\underline{101.6}$	4.00			46.8	2.00							$\underline{2.00}$	$\underline{2.00}$			0	0			2.00	2.00		
$V_N = 1$									46.8	2.00			$\underline{50.8}$	2.00											$\underline{2.00}$	$\underline{2.00}$			2.00	2.00		
$V_{BLOCK} = 1$	$\underline{4.00}$	4.00			$\underline{8.00}$	8.00			$\underline{8.00}$	8.00			$\underline{4.00}$	4.00			$\underline{4.00}$	$\underline{4.00}$			0	0			0	0			4.00	4.00		
$V_B = 1$	2.00	$\underline{57.2}$	2.00		2.00	49.2	2.00										2.00	0	$\underline{2.00}$		$\underline{2.00}$	0	2.00									
$V_F = 1$	2.00	49.2	2.00		4.00	$\underline{114.4}$	4.00		2.00	49.2	2.00						2.00	0	$\underline{2.00}$		0	0	0		$\underline{2.00}$	0	2.00					
$V_K = 1$					2.00	49.2	2.00		4.00	$\underline{114.4}$	4.00		2.00	49.2	2.00						2.00	0	$\underline{2.00}$		0	0	0		$\underline{2.00}$	0	2.00	
$V_O = 1$									2.00	49.2	2.00		2.00	$\underline{57.2}$	2.00										2.00	0	$\underline{2.00}$		$\underline{2.00}$	0	2.00	
$V_{BLOCK} = 1$	4.00	$\underline{8.00}$	4.00		8.00	$\underline{16.00}$	8.00		8.00	$\underline{16.00}$	8.00		4.00	$\underline{8.00}$	4.00		4.00	0	$\underline{4.00}$		0	0	0		0	0	0		$\underline{4.00}$	0	4.00	
$V_C = 1$		2.00	$\underline{57.2}$	2.00		2.00	49.2	2.00										2.00	0	$\underline{2.00}$		$\underline{2.00}$	0	2.00								
$V_G = 1$		2.00	49.2	2.00		4.00	$\underline{103.3}$ / $\underline{114.4}$	2.00 / 4.00		2.00	48.1 / 49.2	0 / 2.00						2.00	0	$\underline{2.00}$		0	2.00 / 0	2.00 / 0		$\underline{2.00}$	$\underline{2.00}$ / 0	0 / 2.00				
$V_L = 1$						2.00	48.1 / 49.2	0 / 2.00		4.00	$\underline{103.3}$ / $\underline{114.4}$	2.00 / 4.00		2.00	49.2	2.00						2.00	2.00 / 0	0 / $\underline{2.00}$		0	$\underline{2.00}$ / 0	$\underline{2.00}$ / 0		$\underline{2.00}$	0	2.00
$V_P = 1$										2.00	49.2	2.00		2.00	$\underline{57.2}$	2.00										2.00	0	$\underline{2.00}$		$\underline{2.00}$	0	2.00
$V_{BLOCK} = 1$		4.00	$\underline{8.00}$	4.00		8.00	$\underline{12.00}$ / $\underline{16.00}$	4.00 / 8.00		8.00	$\underline{12.00}$ / $\underline{16.00}$	4.00 / 8.00		4.00	$\underline{8.00}$	4.00		4.00	0	$\underline{4.00}$		0	$\underline{4.00}$ / 0	$\underline{4.00}$ / 0		0	$\underline{4.00}$ / 0	$\underline{4.00}$ / 0		$\underline{4.00}$	0	4.00
$V_D = 1$			2.00	$\underline{50.8}$			2.00	46.8											2.00	2.00			$\underline{2.00}$	$\underline{2.00}$								
$V_H = 1$			2.00	46.8			2.00 / 4.00	$\underline{57.5}$ / $\underline{101.6}$			0 / 2.00	47.1 / 46.8							2.00	2.00			$\underline{2.00}$ / 0	$\underline{2.00}$ / 0			0 / $\underline{2.00}$	0 / $\underline{2.00}$				
$V_M = 1$							0 / 2.00	47.1 / 46.8			2.00 / 4.00	$\underline{57.5}$ / $\underline{101.6}$			2.00	46.8							0 / 2.00	0 / 2.00			2.00 / 0	2.00 / 0			$\underline{2.00}$	$\underline{2.00}$
$V_Q = 1$											2.00	46.8			2.00	$\underline{50.8}$											2.00	2.00			$\underline{2.00}$	$\underline{2.00}$
$V_{BLOCK} = 1$			4.00	$\underline{4.00}$			4.00 / 8.00	$\underline{4.00}$ / $\underline{8.00}$			4.00 / 8.00	$\underline{4.00}$ / $\underline{8.00}$			4.00	$\underline{4.00}$			4.00	4.00			$\underline{4.00}$ / 0	$\underline{4.00}$ / 0			4.00 / 0	4.00 / 0			$\underline{4.00}$	$\underline{4.00}$

UNDERLINED NUMBERS ARE NEGATIVE.
FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 2. OPERATIONS TABLE FOR MODEL WITHOUT CUTOUT AND WITH SINGLE CUTOUT. SHEET 2.

(WHERE TWO FIGURES APPEAR IN A BOX, THE LOWER PERTAINS TO THE FORMER CONDITION, THE UPPER TO THE LATTER CONDITION)

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
$U_A = 1$	$\underline{2.00}$	2.00			$\underline{2.00}$	2.00											$\underline{50.8}$	46.8			2.00	2.00										
$U_B = 1$	$\underline{2.00}$	0	2.00		$\underline{2.00}$	0	2.00										46.8	$\underline{101.6}$	46.8		2.00	4.00	2.00									
$U_C = 1$		$\underline{2.00}$	0	2.00		$\underline{2.00}$	0	2.00										46.8	$\underline{101.6}$	46.8		2.00	4.00	2.00								
$U_D = 1$			$\underline{2.00}$	2.00			$\underline{2.00}$	2.00											46.8	$\underline{50.8}$			$\underline{2.00}$	2.00								
$U_{BLOCK} = 1$	$\underline{4.00}$	0	0	4.00	$\underline{4.00}$	0	0	4.00									$\underline{4.00}$	$\underline{8.00}$	$\underline{8.00}$	$\underline{4.00}$	4.00	8.00	8.00	4.00								
$U_E = 1$	2.00	$\underline{2.00}$			0	0			$\underline{2.00}$	2.00							2.00	2.00			$\underline{55.8}$	47.8			2.00	2.00						
$U_F = 1$	2.00	0	$\underline{2.00}$		0	0	0		$\underline{2.00}$	0	2.00						2.00	4.00	2.00		47.8	$\underline{111.6}$	47.8		2.00	4.00	2.00					
$U_G = 1$		2.00	0	$\underline{2.00}$		0	2.00 0	2.00 0		$\underline{2.00}$	2.00 0	0 2.00						2.00	4.00	2.00		47.8	$\underline{106.6}$ 111.6	44.8 47.8		2.00	2.00 4.00	0 2.00				
$U_H = 1$			2.00	$\underline{2.00}$			2.00 0	2.00 0			0 2.00	0 2.00							2.00	2.00			44.8 47.8	$\underline{50.8}$ $\underline{55.8}$			0 2.00	0 2.00				
$U_{BLOCK} = 1$	4.00	0	0	$\underline{4.00}$	0	0	4.00 0	4.00 0	$\underline{4.00}$	0	4.00 0	0 4.00					4.00	8.00	8.00	4.00	$\underline{8.00}$	$\underline{16.00}$	$\underline{12.00}$ 16.00	4.00 8.00	4.00	8.00	4.00 8.00	0 4.00				
$U_J = 1$					2.00	$\underline{2.00}$			0	0			$\underline{2.00}$	2.00							2.00	2.00			$\underline{55.8}$	47.8			2.00	2.00		
$U_K = 1$					2.00	0	$\underline{2.00}$		0	0	0		$\underline{2.00}$	0	2.00						2.00	4.00	2.00		47.8	$\underline{111.6}$	47.8		2.00	4.00	2.00	
$U_L = 1$						2.00	$\underline{2.00}$ 0	0 2.00		0	$\underline{2.00}$ 0	2.00 0		$\underline{2.00}$	0	2.00						2.00	2.00 4.00	0 2.00		47.8	$\underline{106.6}$ 111.6	44.8 47.8		2.00	4.00	2.00
$U_M = 1$							0 2.00	0 2.00			$\underline{2.00}$ 0	2.00 0			$\underline{2.00}$	2.00							0 2.00	0 2.00			44.8 47.8	$\underline{50.8}$ $\underline{55.8}$			2.00	2.00
$U_{BLOCK} = 1$					4.00	0	$\underline{4.00}$ 0	0 4.00	0	0	$\underline{4.00}$ 0	4.00 0	$\underline{4.00}$	0	0	4.00					4.00	8.00	4.00 8.00	0 4.00	$\underline{8.00}$	$\underline{16.00}$	$\underline{12.00}$ 16.00	4.00 8.00	4.00	8.00	8.00	4.00
$U_N = 1$									2.00	$\underline{2.00}$			2.00	$\underline{2.00}$											2.00	2.00			$\underline{50.8}$	46.8		
$U_O = 1$									2.00	0	$\underline{2.00}$		2.00	0	$\underline{2.00}$										2.00	4.00	2.00		46.8	$\underline{101.6}$	46.8	
$U_P = 1$										2.00	0	$\underline{2.00}$		2.00	0	$\underline{2.00}$										2.00	4.00	2.00		46.8	$\underline{101.6}$	46.8
$U_Q = 1$											2.00	$\underline{2.00}$			2.00	$\underline{2.00}$											2.00	2.00			46.8	$\underline{50.8}$
$U_{BLOCK} = 1$									4.00	0	0	$\underline{4.00}$	4.00	0	0	$\underline{4.00}$									4.00	8.00	8.00	4.00	$\underline{4.00}$	$\underline{8.00}$	$\underline{8.00}$	$\underline{4.00}$

UNDERLINED NUMBERS ARE NEGATIVE.
FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 3. GROUP OPERATIONS TABLE FOR MODEL WITHOUT CUTOUT

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q
$V_A = V_D = 1$	$\underline{50.8}$	2.00	2.00	$\underline{50.8}$	46.8	2.00	2.00	46.8								
$V_J = V_M = 1$					46.8	2.00	2.00	46.8	$\underline{101.6}$	4.00	4.00	$\underline{101.6}$	46.8	2.00	2.00	46.8
$V_N = V_Q = 1$									46.8	2.00	2.00	46.8	$\underline{50.8}$	2.00	2.00	$\underline{50.8}$
$V_B = V_C = 1$	2.00	$\underline{55.2}$	$\underline{55.2}$	2.00	2.00	51.2	51.2	2.00								
$V_K = V_L = 1$					2.00	51.2	51.2	2.00	4.00	$\underline{110.4}$	$\underline{110.4}$	4.00	2.00	51.2	51.2	2.00
$V_O = V_P = 1$									2.00	51.2	51.2	2.00	2.00	$\underline{55.2}$	$\underline{55.2}$	2.00
$U_B = -U_C = 1$	$\underline{2.00}$	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	2.00	2.00	$\underline{2.00}$								
$U_A = -U_D = 1$	$\underline{2.00}$	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	2.00	2.00	$\underline{2.00}$								
$U_E = -U_H = 1$	2.00	$\underline{2.00}$	$\underline{2.00}$	2.00					$\underline{2.00}$	2.00	2.00	$\underline{2.00}$				
$U_F = -U_G = 1$	2.00	$\underline{2.00}$	$\underline{2.00}$	2.00					$\underline{2.00}$	2.00	2.00	$\underline{2.00}$				
$U_J = -U_M = 1$					2.00	$\underline{2.00}$	$\underline{2.00}$	2.00					$\underline{2.00}$	2.00	2.00	$\underline{2.00}$
$U_K = -U_L = 1$					2.00	$\underline{2.00}$	$\underline{2.00}$	2.00					$\underline{2.00}$	2.00	2.00	$\underline{2.00}$
$U_N = -U_Q = 1$									2.00	$\underline{2.00}$	$\underline{2.00}$	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	2.00
$U_O = -U_P = 1$									2.00	$\underline{2.00}$	$\underline{2.00}$	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	2.00
$V_{AEJN} = V_{DHMQ} = 1$	$\underline{4.00}$	4.00	4.00	$\underline{4.00}$	$\underline{8.00}$	8.00	8.00	$\underline{8.00}$	$\underline{8.00}$	8.00	8.00	$\underline{8.00}$	$\underline{4.00}$	4.00	4.00	$\underline{4.00}$

DISPL.	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
$V_A = V_D = 1$	$\underline{2.00}$	$\underline{2.00}$	2.00	2.00	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$								
$V_J = V_M = 1$					$\underline{2.00}$	$\underline{2.00}$	2.00	2.00					2.00	2.00	$\underline{2.00}$	$\underline{2.00}$
$V_N = V_Q = 1$									$\underline{2.00}$	$\underline{2.00}$	2.00	2.00	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$
$V_B = V_C = 1$	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	$\underline{2.00}$	$\underline{2.00}$	2.00	2.00								
$V_K = V_L = 1$					2.00	2.00	$\underline{2.00}$	$\underline{2.00}$					$\underline{2.00}$	$\underline{2.00}$	2.00	2.00
$V_O = V_P = 1$									2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	$\underline{2.00}$	$\underline{2.00}$	2.00	2.00
$U_B = -U_C = 1$	46.8	$\underline{48.4}$	48.4	$\underline{46.8}$	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$								
$U_A = -U_D = 1$	$\underline{50.8}$	46.8	$\underline{46.8}$	50.8	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$								
$U_E = -U_H = 1$	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	$\underline{55.8}$	47.8	$\underline{47.8}$	55.8	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$				
$U_F = -U_G = 1$	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	47.8	$\underline{59.4}$	59.4	$\underline{47.8}$	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$				
$U_J = -U_M = 1$					2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	$\underline{55.8}$	47.8	$\underline{47.8}$	55.8	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$
$U_K = -U_L = 1$					2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	47.8	$\underline{59.4}$	59.4	$\underline{47.8}$	2.00	2.00	$\underline{2.00}$	$\underline{2.00}$
$U_N = -U_Q = 1$									2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	$\underline{50.8}$	46.8	$\underline{46.8}$	50.8
$U_O = -U_P = 1$									2.00	2.00	$\underline{2.00}$	$\underline{2.00}$	46.8	$\underline{48.4}$	48.4	$\underline{46.8}$
$V_{AEJN} = V_{DHMQ} = 1$	$\underline{4.00}$	$\underline{4.00}$	4.00	4.00									4.00	4.00	$\underline{4.00}$	$\underline{4.00}$

UNDERLINED NUMBERS ARE NEGATIVE.
FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 4. RELAXATION OF VERTICAL FORCES FOR MODEL WITHOUT CUTOUT.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
EXTERNAL LOADS	-120			-120									60	60	60	60																
$V_A = V_D = -2.16$	110	-4	-4	110	-101	-4	-4	-101									4	4	-4	-4	-4	-4	4	4								
	-10	-4	-4	-10	-101	-4	-4	-101									4	4	-4	-4	-4	-4	4	4								
$V_J = V_M = 1.73$					81	3	3	81	-176	7	7	-176	81	3	3	81					-3	-3	3	3					3	3	-3	-3
					-20	-1	-1	-20	-176	7	7	-176	141	63	63	141					-7	-7	7	7					3	3	-3	-3
$V_N = V_Q = 3.33$									156	7	7	156	-169	7	7	-169									-7	-7	7	7	7	7	-7	-7
									-20	14	14	-20	-28	70	70	-28									-7	-7	7	7	10	10	-10	-10
$V_B = V_C = -.25$	-1	14	14	-1	-1	-13	-13	-1									-1	-1	1	1	1	1	-1	-1								
	-11	10	10	-11	-21	-14	-14	-21									3	3	-3	-3	-6	-6	6	6								
$V_K = V_L = .66$					1	34	34	1	3	-73	-73	3	1	34	34	1					1	1	-1	-1					-1	-1	1	1
					-20	20	20	-20	-17	-59	-59	-17	-27	104	104	-27					-5	-5	5	5					9	9	-9	-9
$V_O = V_P = 1.54$									3	79	79	3	3	-85	-85	3									3	3	-3	-3	-3	-3	3	3
									-14	20	20	-14	-24	19	19	-24									-4	-4	4	4	6	6	-6	-6
$V_{AEJN} = V_{DHMQ} = -.25$	10	-10	-10	10	20	-20	-20	20	20	-20	-20	20	10	-10	-10	10	10	10	-10	-10									-10	-10	10	10
	-1	0	0	-1	0	0	0	0	6	0	0	6	-14	9	9	-14	13	13	-13	-13	-5	-5	5	5	-4	-4	4	4	-4	-4	4	4
$V_J = V_M = -.04$					-2			-2	4			4	-2			-2																
					-2			-2	10			10	-16			-16																
$V_N = V_Q = -.25$									-12	-1	-1	-12	13	-1	-1	13									1	1	-1	-1	-1	-1	1	1
									-2	-1	-1	-2	-3	8	8	-3									-3	-3	3	3	-5	-5	5	5
$V_B = V_C = -.02$		1	1			-1	-1	0																								
		1	1			-1	-1	-2																								
$V_K = V_L = .06$						3	3			-7	-7			3	3																	
						2	2			-8	-8			11	11																	
$V_O = V_P = -.20$										10	10			-11	-11																	
										2	2			0	0																	
$V_{AEJN} = V_{DHMQ} = -.25$	1	-1	-1	1	2	-2	-2	2	2	-2	-2	2	1	-1	-1	1	1	1	-1	-1									-1	-1	1	1
RESIDUAL	0	0	0	0	0	0	0	0	0	0	0	0	-2	-1	-1	-2	14	14	-14	-14	-5	-5	5	5	-3	-3	3	3	-6	-6	6	6

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 5. CHECK OF RELAXATIONS IN TABLE 4.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q
EXTERNAL LOADS	-120			-120									60	60	60	60
$V_A = V_D = -4.91$	250	-10	-10	250	-230	-10	-10	-230								
$V_B = V_C = -.27$	-1	15	15	-1	-1	-14	-14	-1								
$V_E = V_H = -2.75$	-129	-6	-6	-129	280	-11	-11	280	-129	-6	-6	-129				
$V_F = V_G = 0$																
$V_J = V_M = -1.06$					-50	-2	-2	-50	108	-4	-4	108	-50	-2	-2	-50
$V_K = V_L = .72$					1	37	37	1	3	-79	-79	3	1	37	37	1
$V_N = V_Q = .33$									15	1	1	15	-17	1	1	-17
$V_O = V_P = 1.74$									3	89	89	3	3	-96	-96	3
RESIDUAL	0	-1	-1	0	0	0	0	0	0	1	1	0	-3	0	0	-3

DISPL.	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
EXTERNAL LOADS																
$V_A = V_D = -4.91$	10	10	-10	-10	-10	-10	10	10								
$V_B = V_C = -.27$	-1	-1	1	1	1	1	-1	-1								
$V_E = V_H = -2.75$	6	6	-6	-6					-6	-6	6	6				
$V_F = V_G = 0$																
$V_J = V_M = -1.06$					2	2	-2	-2					-2	-2	2	2
$V_K = V_L = .72$					1	1	-1	-1					-1	-1	1	1
$V_N = V_Q = .33$									-1	-1	1	1	1	1	-1	-1
$V_O = V_P = 1.74$									3	3	-3	-3	-3	-3	3	3
RESIDUAL	15	15	-15	-15	-6	-6	6	6	-4	-4	4	4	-5	-5	5	5

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 6. RELAXATION OF HORIZONTAL FORCES FOR MODEL WITHOUT CUTOUT.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q
RESIDUAL FORCES	0	-1	-1	0	0	0	0	0	0	1	1	0	-3	0	0	-3
$U_A=-U_D=.30$	-1	1	1	-1	-1	1	1	-1								
$U_B=-U_C=.20$	-1	0	0	-1	-1	1	1	-1								
$U_A=-U_D=.18$																
$U_B=-U_C=.05$																
$U_E=-U_H=-.09$																
$U_F=-U_G=-.06$																
$U_J=-U_M=-.07$																
$U_K=-U_L=-.04$																
$U_N=-U_Q=-.10$																
$U_O=-U_P=-.07$																
RESIDUAL	-1	0	0	-1	-1	1	1	-1	0	1	1	0	-3	0	0	-3

DISPL.	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
RESIDUAL FORCES	15	15	-15	-15	-6	-6	6	6	-4	-4	4	4	-5	-5	5	5
$U_A=-U_D=.30$	-15	14	-14	15	1	1	-1	-1								
$U_B=-U_C=.20$	0 9	29 -29	-29 29	0 -9	-5	-5	5	5								
$U_A=-U_D=.18$	9 -9	0 8	0 -8	-9 9												
$U_B=-U_C=.05$	0 2	8 -8	-8 8	0 -2												
$U_E=-U_H=-.09$	2	0	0	-2	5	-4	4	-5								
$U_F=-U_G=-.06$					0 -3	-9 9	9 -9	0 3								
$U_J=-U_M=-.07$					-3	0	0	3	4	-3	3	-4				
$U_K=-U_L=-.04$									0 -2	-7 6	7 -6	0 2				
$U_N=-U_Q=-.10$									-2	-1	1	2	5	-5	5	-5
$U_O=-U_P=-.07$													0 -3	-10 10	10 -10	0 3
RESIDUAL	2	0	0	-2	-3	0	0	3	-2	-1	1	2	-3	0	0	3

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 7. CHECK OF RELAXATIONS IN TABLE 6.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q
RESIDUAL FORCES	0	−1	−1	0	0	0	0	0	0	1	1	0	−3	0	0	−3
$U_A = -U_D = .48$	−1	1	1	−1	−1	1	1	−1								
$U_B = -U_C = .25$	−1	1	1	−1	−1	1	1	−1								
$U_E = -U_H = -.09$																
$U_F = -U_G = -.06$																
$U_J = -U_M = -.07$																
$U_K = -U_L = -.04$																
$U_N = -U_Q = -.10$																
$U_O = -U_P = -.07$																
RESIDUAL	−2	1	1	−2	−2	2	2	−2	0	1	1	0	−3	0	0	−3

DISPL.	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
RESIDUAL FORCES	15	15	−15	−15	−6	−6	6	6	−4	−4	4	4	−5	−5	5	5
$U_A = -U_D = .48$	−24	22	−22	24	1	1	−1	−1								
$U_B = -U_C = .25$	12	−37	37	−12	1	1	−1	−1								
$U_E = -U_H = -.09$					5	−4	4	−5								
$U_F = -U_G = -.06$					−3	10	−10	3								
$U_J = -U_M = -.07$									4	−3	3	−4				
$U_K = -U_L = -.04$									−2	6	−6	2				
$U_N = -U_Q = -.10$													5	−5	5	−5
$U_O = -U_P = -.07$													−3	10	−10	3
RESIDUAL	3	0	0	−3	−2	2	−2	2	−2	−1	1	2	−3	0	0	3

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 8. STRESS CALCULATIONS FOR MODEL WITHOUT CUTOUT.

CALCULATION OF STRESSES IN VERTICAL STRINGERS.

MEMBER m	MEMBER n	$V_{m\,TOT} \times 10^4$ IN.	$V_{n\,TOT} \times 10^4$ IN.	$(V_{n\,TOT} - V_{m\,TOT})10^4$	$K \times 10^{-4}$ $\frac{LB.}{IN.^2}$/IN.	STRESS PSI.
AE	DH	- 4.91	- 2.75	2.16	375	810
EJ	HM	- 2.75	- 1.06	1.69	"	634
JN	MQ	- 1.06	.33	1.39	"	521
BF	CG	- .27	0	.27	"	101
FK	GL	0	.72	.72	"	270
KO	LP	.72	1.74	1.02	"	382

CALCULATION OF STRESSES IN HORIZONTAL STRIPS.

MEMBER m	MEMBER n	$U_{m\,TOT} \times 10^4$ IN.	$U_{n\,TOT} \times 10^4$ IN.	$(U_{n\,TOT} - U_{m\,TOT})10^4$	$K \times 10^{-4}$ $\frac{LB.}{IN.^2}$/IN.	STRESS PSI.
AB	CD	.48	.25	- .23	375	- 86
BC		25	-.25	- .50	"	-187
EF	GH	-.09	-.06	.03	"	11
FG		-.06	.06	.12	"	45
JK	LM	-.07	-.04	.03	"	11
KL		-.04	.04	.08	"	30
NO	PQ	-.10	-.07	.03	"	11
OP		-.07	.07	.14	"	53

TABLE 9. GROUP OPERATIONS TABLE FOR MODEL WITH SINGLE CUTOUT.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q
$U_F = -U_G = 1$	2.00	2.00	2.00	2.00			2.00	2.00	2.00	2.00	0	0				
$U_K = -U_L = 1$					2.00	2.00	0	0			2.00	2.00	2.00	2.00	2.00	2.00
$V_{DHMQ} = 1$			4.00	4.00			4.00	4.00			4.00	4.00			4.00	4.00
$V_{CGLP} = 1$		4.00	8.00	4.00		6.00	12.00	4.00		6.00	12.00	4.00		4.00	8.00	4.00
$V_M = V_Q = 1$								47.1			4.00	51.1			4.00	4.00
$V_D = V_H = 1$			4.00	4.00			4.00	51.1				47.1				
$U_G = U_H = 1$		2.00	2.00	4.00			4.00	4.00		2.00	2.00	0				
$U_G = -U_H = 1$		2.00	2.00	0			0	0		2.00	2.00					
$U_F = U_G = 1$	2.00	2.00	2.00	2.00			2.00	2.00	2.00	2.00	4.00					
$U_E = -U_H = 1$	2.00	2.00	2.00	2.00			2.00	2.00	2.00	2.00						
$U_J = -U_M = 1$					2.00	2.00					2.00	2.00	2.00	2.00	2.00	2.00
$U_{ABCD} = U_{JKLM} = -1$	4.00			4.00	0		4.00	4.00			4.00	4.00	4.00			4.00

DISPL.	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
$U_F = -U_G = 1$	2.00	2.00	2.00	2.00	47.8	53.4	54.4	46.8	2.00	2.00	0	0				
$U_K = -U_L = 1$					2.00	2.00	0	0	47.8	53.4	54.4	46.8	2.00	2.00	2.00	2.00
$V_{DHMQ} = 1$			4.00	4.00			4.00	4.00			4.00	4.00			4.00	4.00
$V_{CGLP} = 1$		4.00	0	4.00		0	4.00	4.00		0	4.00	4.00		4.00	0	4.00
$V_M = V_Q = 1$											4.00	4.00			4.00	4.00
$V_D = V_H = 1$			4.00	4.00			4.00	4.00								
$U_G = U_H = 1$		2.00	6.00	4.00		47.8	51.8	4.00		2.00	2.00	0				
$U_G = -U_H = 1$		2.00	2.00	0		47.8	53.4	97.6		2.00	2.00					
$U_F = U_G = 1$	2.00	6.00	6.00	2.00	47.8	63.8	58.8	46.8	2.00	6.00	4.00					
$U_E = -U_H = 1$	2.00	2.00	2.00	2.00	55.8	47.8	46.8	50.8	2.00	2.00						
$U_J = -U_M = 1$					2.00	2.00			55.8	47.8	46.8	50.8	2.00	2.00	2.00	2.00
$U_{ABCD} = U_{JKLM} = -1$	4.00	8.00	8.00	4.00	8.00	16.00	12.00	4.00	8.00	16.00	12.00	4.00	4.00	8.00	8.00	4.00

UNDERLINED NUMBERS ,ARE NEGATIVE.
FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 10. CHECK TABLE OF RELAXATIONS FOR MODEL WITHOUT CUTOUT WITH OPERATIONS PERTAINING TO MODEL WITH SINGLE CUTOUT.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
EXTERNAL LOADS	-120			-120									60	60	60	60																
$V_A = V_D = -4.91$	250	-10	-10	250	-230	-10	-10	-230									10	10	-10	-10	-10	-10	10	10								
$V_B = V_C = -.27$	-1	15	15	-1	-1	-14	-14	-1									-1	-1	1	1	1	1	-1	-1								
$V_E = V_H = 2.75$	-129	-6	-6	-129	280	-11	-6	269	-129	-6	0	-130					6	6	-6	-6			6	6	-6	-6						
$V_F = V_G = 0$																																
$V_J = V_M = -1.06$					-50	-2	0	-50	108	-4	-2	104	-50	-2	-2	-50					2	2					-2	-2	-2	-2	2	2
$V_K = V_L = .72$					1	37	36	0	3	-79	-76	1	1	37	37	1					1	1					-1	-1	-1	-1	1	1
$V_N = V_Q = .33$									15	1	1	15	-17	1	1	-17									-1	-1	1	1	1	1	-1	-1
$V_O = V_P = 1.74$									3	89	89	3	3	-96	-96	3									3	3	-3	-3	-3	-3	3	3
$U_A = -U_D = .48$	-1	1	1	-1	-1	1	1	-1									-24	22	-22	24	1	1	-1	-1								
$U_B = -U_C = .25$	-1	1	1	-1	-1	1	1	-1									12	-37	37	-12	1	1	-1	-1								
$U_E = -U_H = -.09$																					5	-4	4	-5								
$U_F = -U_G = -.06$																					-3	10	-9	3								
$U_J = -U_M = -.07$																									4	-3	3	-4				
$U_K = -U_L = -.04$																									-2	6	-6	2				
$U_N = -U_Q = -.10$																													5	-5	5	-5
$U_O = -U_P = -.07$																													-3	10	-10	3
RESIDUAL	-2	1	1	-2	-2	2	8	-14	0	1	12	-7	-3	0	0	-3	3	0	0	-3	-2	2	8	11	-2	-1	-8	-7	-3	0	0	3

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE II. RELAXATION OF RESIDUAL VERTICAL FORCES FOR MODEL WITH SINGLE CUTOUT.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
RESIDUAL FORCES	-2	1	1	-2	-2	2	8	-14	0	1	12	-7	-3	0	0	-3	3	0	0	-3	-2	2	8	11	-2	-1	-8	-7	-3	0	0	3
$V_M = V_Q = -.14$								-7			-1	7			-1	1											-1	-1			1	1
$V_D = V_H = -.41$			-2	2			-2	-21 21			11	0 -19			-1	-2			-2	-2			2	2			-9	-8			1	4
$V_M = V_Q = -.37$			-1	0			6	0 -17			-1	-19 19			-1	1			-2	-5			10	13			-1	-1			1	1
$V_D = V_H = -.33$			-1	1			-1	-17 17			10	0 -16			-2	-1			-1	-1			1	1			-10	-9			2	5
$V_M = V_Q = -.31$			-2	1			5	0 -15			-1	-16 16			-1	1			-3	-6			11	14			-1	-1			1	1
$V_D = V_H = -.29$			-1	1			-1	-15 15			9	0 -14			-3	0			-1	-1			1	1			-11	-10			3	6
$V_M = V_Q = -.27$			-3	2			4	0 -13			-1	-14 14			-1	1			-4	-7			12	15			-1	-1			1	1
$V_H = -.13$				-6				-13 13			8	0 -6			-4	1											-12	-11			4	7
$V_M = -.06$				-4				0 -3				-6 6				-3																
$V_L = .07$							3	-3			-8	0			3	-2																
$V_C = .06$			3				7 -7				0 3				-1																	
$V_D = -.08$			0	4			0	-4			3																					
$V_H = -.07$				0 -3				-7 7				-3																				
$V_{DHMQ} = -.5$			-2	-3 2			-2	0 2			-2	-3 2			-2	2			-2	-2			2	2			-2	-2			2	2
RESIDUAL	-2	1	-2	-1	-2	2	-2	2	0	1	1	-1	-3	0	-3	0	3	0	-6	-9	-2	2	14	17	-2	-1	-14	-13	-3	0	6	9

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 12. CHECK OF RELAXATIONS IN TABLE 11.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q
RESIDUAL FORCES	-2	1	1	-2	-2	2	8	-14	0	1	12	-7	-3	0	0	-3
$V_D = -1.61$			-3	82			-3	-75								
$V_H = -1.73$			-3	-81			-3	169				-81				
$V_M = -1.65$								-78			-3	162			-3	-77
$V_Q = -1.59$											-3	-75			-3	81
$V_C = 0$																
$V_G = .06$			3				-7				3					
$V_L = .07$							3				-8				3	
RESIDUAL	-2	1	-2	-1	-2	2	-2	2	0	1	1	-1	-3	0	-3	1

DISPL.	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
RESIDUAL FORCES	3	0	0	-3	-2	2	8	11	-2	-1	-8	-7	-3	0	0	3
$V_D = -1.61$			-3	-3			3	3								
$V_H = -1.73$			-3	-3			3	3								
$V_M = -1.65$											-3	-3			3	3
$V_Q = -1.59$											-3	-3			3	3
$V_C = 0$																
$V_G = .06$																
$V_L = .07$																
RESIDUAL	3	0	-6	-9	-2	2	14	17	-2	-1	-14	-13	-3	0	6	9

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 13. RELAXATION OF RESIDUAL HORIZONTAL FORCES FOR MODEL WITH SINGLE CUTOUT. SHEET 1.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
RESIDUAL FORCES	-2	1	-2	-1	-2	2	-2	2	0	1	1	-1	-3	0	-3	1	3	0	-6	-9	-2	2	14	17	-2	-1	-14	-13	-3	0	6	9
$u_D = -.10$																			-5	5												
$u_B = .06$																	3	-6	-11 3	-4												
$u_H = .26$			1	-1			1	-1									6	-6	-8 1	1			12	-13								
$u_F = -.29$	-1		-1 1	-2			-1	1	1		-1						-1	-1	-7 -1	-3	-14	32	26 -14	4	-1	-1	-1					
$u_E = -.38$	-3 -1	1	0						1 1	-1	0						5 -1	-7 -1	-8		-16 21	34 -18	12		-3 -1	-2 -1	-15					
$u_M = -.18$	-4	2							2	0							4	-8			5	16			-4	-3	-8	9				
$u_K = .23$																						1			11	-26	-23 11	-4		1		
$u_J = .27$					1	-1							-1	1							1	17 1			7 -15	-29 13	-12		1	1 1		
$u_Q = .10$					-1	1							-4	1							6	18			-8	-16			-2	2	5	-5
$u_O = -.06$																													-3	6	11 -3	4
$U_{ABCD} = U_{JKLM} = -1$	4			-4			4	-4			4	-4	4			-4	4	8	8	4	-8	-16	-12	-4	8	16	12	4	-5 -4	8 -8	8 -8	-4
RESIDUAL	0	2	0	-6	-1	1	3	-3	2	0	4	-5	0	1	-3	-3	8	0	0	1	-2	2	0	0	0	0	0	0	-9	0	0	0

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 13. RELAXATION OF RESIDUAL HORIZONTAL FORCES FOR MODEL WITH SINGLE CUTOUT. SHEET 2.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
RESIDUAL FORCES	0	2	0	-6	-1	1	3	-3	2	0	4	-5	0	1	-3	-3	8	0	0	1	-2	2	0	0	0	0	0	0	-9	0	0	0
$U_A = .12$																	-6	6														
$U_C = -.06$																	2	6 -3	6	-3												
$U_D = -.09$																		3	6 -4	-2 5												
$U_M = -.14$																			2	3									7	-7		
$U_P = .09$																													-2	-7 4	-9	4
$U_Q = .13$																														-3	-9 6	4 -7
$V_{DHMQ} = -5$			-2	2			-2	2			-2	2			-2	2			-2	-2			2	2			-2	-2			-3 2	-3 2
RESIDUAL	0	2	-2	-4	-1	1	1	-1	2	0	2	-3	1	0	-5	-1	2	3	0	1	-2	2	2	2	0	0	-2	-2	-2	-3	-1	-1

* FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 14. COMPLETE CHECK TABLE FOR MODEL WITH SINGLE CUTOUT.

* ADJUSTED VALUES APPEAR AT END OF TABLE. SHEET 1.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
EXTERNAL LOADS	-120			-120									60	60	60	60																
$V_A = -4.91$	250	-10			-230	-10											10	10			-10	-10										
$V_E = -2.75$	-129	-6			279	-11			-129	-6							6	6							-6	-6						
$V_J = -1.06$					-50	-2			108	-4			-50	-2							2	2							-2	-2		
$V_N = .33$									15	1			-17	1											-1	-1			1	1		
$V_B = -.27$	-1	15	-1		-1	-13	-1										-1		1		1		-1									
$V_F = 0$																																
$V_K = .72$					1	35	1		3	-82	3		1	35	1						1		-1						-1		1	
$V_O = 1.74$									3	86	3		3	-100	3										3		-3		-3		3	
$V_C = -.27$		-1	15	-1		-1	-13	-1										-1		1		1		-1								
$V_G = .06$			3				-7				.3																					
$V_L = .79$						2	38			3	-86	2		2	39	2						2	2				-2	-2		-2		2
* $V_P = 1.74$										3	86	3		3	-100	3										3		-3		-3		3
* $V_D = -7.02$			-14	357			-14	-329											-14	-14			14	14								
$V_H = -4.98$			-10	-233			-10	488				-235							-10	-10			10	10								
$V_M = -3.21$								-151			-6	314			-6	-150											-6	-6			6	6
$V_Q = -1.76$											-4	-82			-4	89											-4	-4			4	4
$U_A = -.40$	1	-1			1	-1											20	-19			-1	-1										
$U_B = -.69$	1		-1		1		-1										-32	70	-32		-1	-3	-1									
$U_C = -1.31$		3		-3		3		-3										-61	133	-61		-3	-5	-3								
$U_D = -1.67$			3	-3			3	-3											-78	85			-3	-3								

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 14. COMPLETE CHECK TABLE FOR MODEL WITH SINGLE CUTOUT.

* ADJUSTED VALUES APPEAR AT END OF TABLE. SHEET 2.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q
$U_E = -.47$	-1	1							1	-1						
$U_F = -.35$	-1		1						1		-1					
*$U_G = .06$																
$U_H = .35$			1	-1			1	-1								
$U_J = -.80$					-2	2							2	-2		
$U_K = -.81$					-2		2						2		-2	
$U_L = -.96$						-2	2				2	-2		2		-2
$U_M = -1.11$											2	-2			2	-2
$U_N = -.24$																
*$U_O = -.13$																
$U_P = .16$																
$U_Q = .33$											1	-1			1	-1
RESIDUAL	0	1	-3	-4	-3	2	1	0	2	0	3	-3	1	-1	-6	-1
*$V_D = -7.07$			-14	359			-14	-331								
*$V_P = 1.66$										3	82	3		3	-95	3
*$U_G = .09$																
*$U_O = -.135$																
FINAL RESIDUAL FORCES	0	1	-3	-2	-3	2	1	-2	2	0	-1	-3	1	-1	-1	-1

DISPL.	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
$U_E = -.47$	-1	-1			26	-22			-1	-1						
$U_F = -.35$	-1	-1	-1		-17	39	-17		-1	-1	-1					
*$U_G = .06$						3	-6	3								
$U_H = .35$			1	1			16	-18								
$U_J = -.80$					-2	-2			45	-38			-2	-2		
$U_K = -.81$					-2	-3	-2		-39	90	-39		-2	-3	-2	
$U_L = -.96$						-2	-2			-46	102	-45		-2	-4	-2
$U_M = -1.11$											-52	56			-2	-2
$U_N = -.24$													12	-11		
*$U_O = -.13$										-1			-6	13	-6	
$U_P = .16$											1			7	-16	7
$U_Q = .33$											1	1			15	-17
RESIDUAL	1	3	0	2	-3	1	4	2	0	-1	-3	-3	-3	-4	-1	1
*$V_D = -7.07$			-14	-14			14	14								
*$V_P = 1.66$										3		-3		-3		3
*$U_G = .09$						4	-10	4								
*$U_O = -.135$										-1			-6	14	-6	
FINAL RESIDUAL FORCES	1	3	0	2	-3	2	0	3	0	-1	-3	-3	-3	-3	-1	1

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 15. STRESS CALCULATIONS FOR MODEL WITH SINGLE CUTOUT.

CALCULATION OF STRESSES IN VERTICAL STRINGERS.

MEMBER mn	$V_{m\,TOT} \times 10^4$ IN.	$V_{n\,TOT} \times 10^4$ IN.	$(V_{n\,TOT} - V_{m\,TOT})10^4$	$K \times 10^{-4}$ $\frac{LB.}{IN.^2}$/IN.	STRESS PSI.
AE	-4.91	-2.75	2.16	375	810
DH	-7.07	-4.98	2.09	"	785
EJ	-2.75	-1.06	1.69	"	634
HM	-4.98	-3.21	1.77	"	664
JN	-1.06	.33	1.39	"	521
MQ	-3.21	-1.76	1.45	"	544
BF	-.27	0	.27	"	101
CG	-.27	.06	.33	"	124
FK	0	.72	.72	"	270
GL	.06	.79	.73	"	274
KO	.72	1.74	1.02	"	382
LP	.79	1.66	.87	"	326

CALCULATION OF STRESSES IN HORIZONTAL STRIPS.

MEMBER mn	$U_{m\,TOT} \times 10^4$ IN.	$U_{n\,TOT} \times 10^4$ IN.	$(U_{n\,TOT} - U_{m\,TOT})10^4$	$K \times 10^{-4}$ $\frac{LB.}{IN.^2}$/IN.	STRESS PSI.
AB	-.40	-.69	-.29	375	-109
BC	-.69	-1.31	-.62	"	-232
CD	-1.31	-1.67	-.36	"	-135
EF	-.47	-.35	.12	"	45
FG	-.35	.09	.44	"	165
GH	.09	.35	.26	"	98
JK	-.80	-.81	-.01	"	-4
KL	-.81	-.96	-.15	"	-56
LM	-.96	-1.11	-.15	"	-56
NO	-.24	-.135	.105	"	39
OP	-.135	.16	.295	"	111
PQ	.16	.33	.17	"	64

TABLE 16. OPERATIONS TABLE FOR MODEL WITH DOUBLE CUTOUT. SHEET 1.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q
$V_A = 1$	$\underline{50.8}$	2.00			46.8	2.00										
$V_E = 1$	46.8	2.00			$\underline{101.6}$	4.00			46.8	2.00						
$V_J = 1$					46.8	2.00			$\underline{101.6}$	4.00			46.8	2.00		
$V_N = 1$									46.8	2.00			$\underline{50.8}$	2.00		
$V_{BLOCK} = 1$	$\underline{4.00}$	4.00			$\underline{8.00}$	8.00			$\underline{8.00}$	8.00			$\underline{4.00}$	4.00		
$V_B = 1$	2.00	$\underline{57.2}$	2.00		2.00	49.2	2.00									
$V_F = 1$	2.00	49.2	2.00		4.00	$\underline{109.3}$	2.00		2.00	48.1	0					
$V_K = 1$					2.00	48.1	0		4.00	$\underline{109.3}$	2.00		2.00	49.2	2.00	
$V_O = 1$									2.00	49.2	2.00		2.00	$\underline{57.2}$	2.00	
$V_{BLOCK} = 1$	4.00	$\underline{8.00}$	4.00		8.00	$\underline{12.00}$	4.00		8.00	$\underline{12.00}$	4.00		4.00	$\underline{8.00}$	4.00	
$V_C = 1$		2.00	$\underline{57.2}$	2.00		2.00	49.2	2.00								
$V_G = 1$		2.00	49.2	2.00		2.00	$\underline{57.2}$	2.00								
$V_L = 1$										2.00	$\underline{57.2}$	2.00		2.00	49.2	2.00
$V_P = 1$										2.00	49.2	2.00		2.00	$\underline{57.2}$	2.00
$V_{BLOCK} = 1$		4.00	$\underline{8.00}$	4.00		4.00	$\underline{8.00}$	4.00		4.00	$\underline{8.00}$	4.00		4.00	$\underline{8.00}$	4.00
$V_D = 1$			2.00	$\underline{50.8}$			2.00	46.8								
$V_H = 1$			2.00	46.8			2.00	$\underline{97.9}$			0	47.1				
$V_M = 1$							0	47.1			2.00	$\underline{97.9}$			2.00	46.8
$V_Q = 1$											2.00	46.8			2.00	$\underline{50.8}$
$V_{BLOCK} = 1$			4.00	$\underline{4.00}$			4.00	$\underline{4.00}$			4.00	$\underline{4.00}$			4.00	$\underline{4.00}$

DISPL.	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
$V_A = 1$	$\underline{2.00}$	$\underline{2.00}$			2.00	2.00										
$V_E = 1$	$\underline{2.00}$	$\underline{2.00}$							2.00	2.00						
$V_J = 1$					$\underline{2.00}$	$\underline{2.00}$							2.00	2.00		
$V_N = 1$									$\underline{2.00}$	$\underline{2.00}$			2.00	2.00		
$V_{BLOCK} = 1$	$\underline{4.00}$	$\underline{4.00}$			0	0			0	0			4.00	4.00		
$V_B = 1$	2.00		$\underline{2.00}$		$\underline{2.00}$		2.00									
$V_F = 1$	2.00	0	$\underline{2.00}$		0	2.00	2.00		$\underline{2.00}$	$\underline{2.00}$	0					
$V_K = 1$					2.00	2.00			0	$\underline{2.00}$	$\underline{2.00}$		$\underline{2.00}$	0	2.00	
$V_O = 1$									2.00		$\underline{2.00}$		$\underline{2.00}$		2.00	
$V_{BLOCK} = 1$	4.00		$\underline{4.00}$		0	4.00	4.00		0	$\underline{4.00}$	$\underline{4.00}$		$\underline{4.00}$		4.00	
$V_C = 1$		2.00		$\underline{2.00}$		$\underline{2.00}$		2.00								
$V_G = 1$		2.00	0	$\underline{2.00}$		$\underline{2.00}$	0	2.00								
$V_L = 1$										2.00	0	$\underline{2.00}$		$\underline{2.00}$	0	2.00
$V_P = 1$										2.00		$\underline{2.00}$		$\underline{2.00}$		2.00
$V_{BLOCK} = 1$		4.00		$\underline{4.00}$		$\underline{4.00}$		4.00		4.00		$\underline{4.00}$		$\underline{4.00}$		4.00
$V_D = 1$			2.00	2.00			$\underline{2.00}$	$\underline{2.00}$								
$V_H = 1$			2.00	2.00			$\underline{2.00}$	$\underline{2.00}$			0	0				
$V_M = 1$							0	0			2.00	2.00			$\underline{2.00}$	$\underline{2.00}$
$V_Q = 1$											2.00	2.00			$\underline{2.00}$	$\underline{2.00}$
$V_{BLOCK} = 1$			4.00	4.00			$\underline{4.00}$	$\underline{4.00}$			4.00	4.00			$\underline{4.00}$	$\underline{4.00}$

UNDERLINED NUMBERS ARE NEGATIVE.
FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 16. OPERATIONS TABLE FOR MODEL WITH DOUBLE CUTOUT. SHEET 2.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
$U_A = 1$	$\underline{2.00}$	2.00			$\underline{2.00}$	2.00											$\underline{50.8}$	46.8			2.00	2.00										
$U_B = 1$	$\underline{2.00}$		2.00		$\underline{2.00}$		2.00										46.8	$\underline{101.6}$	46.8		2.00	4.00	2.00									
$U_C = 1$		$\underline{2.00}$		2.00		$\underline{2.00}$		2.00										46.8	$\underline{101.6}$	46.8		2.00	4.00	2.00								
$U_D = 1$			$\underline{2.00}$	2.00			$\underline{2.00}$	2.00											46.8	$\underline{50.8}$			2.00	2.00								
$U_{BLOCK} = 1$	$\underline{4.00}$	0	0	4.00	$\underline{4.00}$	0	0	4.00									$\underline{4.00}$	$\underline{8.00}$	$\underline{8.00}$	$\underline{4.00}$	4.00	8.00	8.00	4.00								
$U_E = 1$	2.00	$\underline{2.00}$							$\underline{2.00}$	2.00							2.00	2.00			$\underline{55.8}$	47.8			2.00	2.00						
$U_F = 1$	2.00	0	$\underline{2.00}$		0	2.00	$\underline{2.00}$		$\underline{2.00}$	2.00							2.00	4.00	2.00		47.8	$\underline{106.6}$	46.8		2.00	2.00						
$U_G = 1$		2.00	0	$\underline{2.00}$		2.00	0	$\underline{2.00}$										2.00	4.00	2.00		46.8	$\underline{101.6}$	46.8								
$U_H = 1$			2.00	$\underline{2.00}$			2.00	$\underline{2.00}$			0	0							2.00	2.00			46.8	$\underline{50.8}$			0	0				
$U_{BLOCK} = 1$	4.00	0	0	$\underline{4.00}$	0	4.00	0	$\underline{4.00}$	$\underline{4.00}$	4.00							4.00	8.00	8.00	4.00	$\underline{8.00}$	$\underline{12.00}$	$\underline{8.00}$	$\underline{4.00}$	4.00	4.00						
$U_J = 1$					2.00	$\underline{2.00}$							$\underline{2.00}$	2.00							2.00	2.00			$\underline{55.8}$	47.8			2.00	2.00		
$U_K = 1$					2.00	$\underline{2.00}$	0		0	$\underline{2.00}$	2.00		$\underline{2.00}$	0	2.00						2.00	2.00	0		47.8	$\underline{106.6}$	46.8		2.00	4.00	2.00	
$U_L = 1$										$\underline{2.00}$	0	2.00		$\underline{2.00}$	0	2.00										46.8	$\underline{101.6}$	46.8		2.00	4.00	2.00
$U_M = 1$							0	0			$\underline{2.00}$	2.00			$\underline{2.00}$	2.00							0	0			46.8	$\underline{50.8}$			2.00	2.00
$U_{BLOCK} = 1$					4.00	$\underline{4.00}$				$\underline{4.00}$	0	4.00	$\underline{4.00}$	0	0	4.00					4.00	4.00			$\underline{8.00}$	$\underline{12.00}$	$\underline{8.00}$	$\underline{4.00}$	4.00	8.00	8.00	4.00
$U_N = 1$									2.00	$\underline{2.00}$			2.00	$\underline{2.00}$											2.00	2.00			$\underline{50.8}$	46.8		
$U_O = 1$									2.00		$\underline{2.00}$		2.00		$\underline{2.00}$										2.00	4.00	2.00		46.8	$\underline{101.6}$	46.8	
$U_P = 1$										2.00		$\underline{2.00}$		2.00		$\underline{2.00}$										2.00	4.00	2.00		46.8	$\underline{101.6}$	46.8
$U_Q = 1$											2.00	$\underline{2.00}$			2.00	$\underline{2.00}$											2.00	2.00			46.8	$\underline{50.8}$
$U_{BLOCK} = 1$									4.00	0	0	$\underline{4.00}$	4.00	0	0	$\underline{4.00}$									4.00	8.00	8.00	4.00	$\underline{4.00}$	$\underline{8.00}$	$\underline{8.00}$	$\underline{4.00}$

UNDERLINED NUMBERS ARE NEGATIVE.
FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 17. CHECK TABLE OF RELAXATIONS FOR MODEL WITH SINGLE CUTOUT WITH OPERATIONS PERTAINING TO MODEL WITH DOUBLE CUTOUT. SHEET 1.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
EXTERNAL LOADS	-124			-124									62	62	62	62																
$V_A = -4.91$	250	-10			-230	-10											10	10			-10	-10										
$V_E = -2.75$	-129	-6			279	-11			-129	-6							6	6							-6	-6						
$V_J = -1.06$					-50	-2			108	-4			-50	-2							2	2							-2	-2		
$V_N = .33$									15	1			-17	1											-1	-1			1	1		
$V_B = -.27$	-1	15	-1		-1	-13	-1										-1		1		1		-1									
$V_F = 0$																																
$V_K = .72$					1	35			3	-79	1		1	35	1						1	1				-1	-1		-1		1	
$V_O = 1.74$									3	86	3		3	-100	3										3		-3		-3		3	
$V_C = -.27$		-1	15	-1		-1	-13	-1										-1		1		1		-1								
$V_G = .06$			3				-3																									
$V_L = .79$										2	-45	2		2	39	2										2		-2		-2		2
$V_P = 1.66$										3	82	3		3	-95	3										3		-3		-3		3
$V_D = -7.07$			-14	359			-14	-331											-14	-14			14	14								
$V_H = -4.98$			-10	-233			-10	488				-235							-10	-10			10	10								
$V_M = -3.21$								-151			-6	314			-6	-150											-6	-6			6	6
$V_Q = -1.76$											-4	-82			-4	89											-4	-4			4	4

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 17. CHECK TABLE OF RELAXATIONS FOR MODEL WITH SINGLE CUTOUT WITH OPERATIONS PERTAINING TO MODEL WITH DOUBLE CUTOUT. SHEET 2.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
$U_A = -.40$	1	-1			1	-1											20	-19			-1	-1										
$U_B = -.69$	1		-1		1		-1										-32	70	-32		-1	-3	-1									
$U_C = -1.31$		3		-3		3		-3										-61	133	-61		-3	-5	-3								
$U_D = -1.67$			3	-3			3	-3											-78	85			-3	-3								
$U_E = -.47$	-1	1							1	-1							-1	-1			26	-22			-1	-1						
$U_F = -.35$	-1		1			-1	1		1	-1							-1	-1	-1		-17	37	-16		-1	-1						
$U_G = .09$																						4	-9	4								
$U_H = .35$			1	-1			1	-1											1	1			16	-18								
$U_J = -.80$					-2	2							2	-2							-2	-2			45	-38			-2	-2		
$U_K = -.81$					-2	2				2	-2		2		-2						-2	-2			-39	86	-38		-2	-3	-2	
$U_L = -.96$										2		-2		2		-2										-45	98	-45		-2	-4	-2
$U_M = -1.11$											2	-2			2	-2											-52	56			-2	-2
$U_N = -.24$																													12	-11		
$U_O = -.135$																										-1			-6	14	-6	
$U_P = .16$																											1			7	-16	7
$U_Q = .33$											1	-1			1	-1											1	1			15	-17
RESIDUAL	-4	1	-3	-6	-3	3	-37	-2	2	5	32	-3	3	1	1	1	1	3	0	2	-3	2	5	3	0	-3	-4	-3	-3	-3	-1	1

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 18. RELAXATION OF RESIDUAL FORCES FOR MODEL WITH DOUBLE CUTOUT.

SHEET 1.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
RESIDUAL FORCES	-4	1	-3	-6	-3	3	-37	-2	2	5	32	-3	3	1	1	1	1	3	0	2	-3	2	5	3	0	-3	-4	-3	-3	-3	-1	1
$V_G = -.31$		-1	-15	-1		-1	18	-1										-1		1		1		-1								
$V_C = V_G = -2.25$		0 -9	-18 18	-7 -9		2 -9	-19 18	-3 -9										2 -9		3 9		3 9		2 -9								
$V_L = .30$		-9	0	-16		-7	-1	-12		1	-17	1		1	15	1		-7		12		12		-7		1		-1		-1		1
$V_L = V_P = 1.88$										6 8	15 -15	-2 8		2 8	16 -15	2 8										-2 8		-4 -8		-4 -8		2 8
$V_B = -.17$		10				-8				14	0	6		10	1	10										6		-12		-12		10
$V_K = .33$		1			1	-15 16			1	-36	1		1	16	1						1	1				-1	-1		-1		1	
$V_O = .45$					-2	1			3 1	-22 22	1 1		4 1	26 -26	2 1						-2	13			1	5	-5 -1		-4 -1		0 1	
$V_A = -.08$	4				-4				4	0	2		5	0	3										1		-6		-5		1	
$V_J = .13$	0				-6 6				-13				6																			
$V_N = .22$					0				-9 10				11 -11																			
$V_D = -.28$			-1	14			-1	-13	1				0						-1	-1			1	1								
$V_Q = .20$			-1	-2			-2	-25				9				-10			-1	11			6	-6			1	1			-1	-1
$V_D = V_H = -.49$			-2	2			-2	25				15 -23				0			-2	-2			2	2			-5	-11			0	9
$V_M = -.06$			-3	0			-4	0 -3				-8 6				0 -3			-3	9			8	-4			-5	-11			0	9
$V_L = V_P = .25$								-3		1	-2	-2 1		1	-2	-3 1										1		-1		-1		1
$V_D = .02$				-1				1		1	0	-1		1	1	-2																
$V_C = V_G = -.25$		-1	2	-1 -1		-1	2	-2 -1										-1		1		1		-1								
RESIDUAL	0	0	-1	-2	0	0	-2	-3	1	1	0	-1	0	1	1	-2	1	-8	-3	10	-2	14	8	-5	1	6	-5	-12	-5	-13	0	10

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 18. RELAXATION OF RESIDUAL FORCES FOR MODEL WITH DOUBLE CUTOUT.

SHEET 2.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
RESIDUAL FORCES	0	0	-1	-2	0	0	-2	-3	1	1	0	-1	0	1	1	-2	1	-8	-3	10	-2	14	8	-5	1	6	-5	-12	-5	-13	0	10
$U_H = -.10$																							-5	5								
$U_F = -.06$																					-3	6	3 -3	0								
$U_E = -.21$																					-5 12	20 -11	0									
$U_M = -.24$																					7	9					-11	12				
$U_K = .34$					1	-1				-1	1		-1		1						1	1			16	-36	-16 16	0	1	1	1	
$U_J = .44$					1 1	-1 -1				0	1		-1 -1	1	2						8 1	10 1			17 -25	-30 21	0		-4 1	-12 1	1	
$U_{ABCD} = U_{EFGH} = 2.00$					2 -8	-2 8			-8	8			-2	2							9 -8	11 -8			-8 8	-9 8			-3	-11		
$U_C = .17$					-6	6			-7	8								8	-17	8	1	3	1		0	-1						
$U_D = .38$																		0	-20 18	18 -19												
$U_N = -.04$																			-2	-1									2	-2		
$U_P = .24$																											1		-1	-13 11	-24	11
$U_Q = .44$																											1			-2	-23 21	21 -22
$V_{AEJN} = -.50$	0 2	0 -2	-1	-2	-6 4	6 -4	-2	-3	-7 4	8 -4	1	-1	-2 2	2 -2	2	-2	1 2	0 2	-2	-1	1	3	1	0	0	-1	1	0	-1 -2	-2 -2	-2	-1
$V_A = -V_B = V_N = -V_O = .04$	2 -2	-2 2			-2 2	2 -2			-3 2	4 -2			0 -2	0 2			3	2											-3	-4		
RESIDUAL	0	0	-1	-2	0	0	-2	-3	-1	2	1	-1	-2	2	2	-2	3	2	-2	-1	1	3	1	0	0	-1	1	0	-3	-4	-2	-1

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 19. COMPLETE CHECK TABLE FOR MODEL WITH DOUBLE CUTOUT.

* ADJUSTED VALUES APPEAR AT END OF TABLE. SHEET 1.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
EXTERNAL LOADS	-124			-124									62	62	62	62																
V_A = -5.45	277	-11			-255	-11											11	11			-11	-11										
V_E = -3.25	-152	-7			330	-13			-152	-7							7	7							-7	-7						
V_J = -1.43					-67	-3			145	-6			-67	-3							3	3							-3	-3		
V_N = .09									4				-5																			
V_B = -.48	-1	27	-1		-1	-24	-1										-1		1		1		-1									
*V_F = 0																																
V_K = 1.05					2	51			4	-115	2		2	52	2						2	2				-2	-2		-2		2	
*V_O = 2.15									4	106	4		4	-123	4										4		-4		-4		4	
V_C = -2.77		-6	158	-6		-6	-136	-6										-6		6		6		-6								
V_G = -2.75		-6	-135	-6		-6	157	-6										-6		6		6		-6								
V_L = 3.22										6	-184	6		6	158	6										6		-6		-6		6
V_P = 3.79										8	186	8		8	-217	8										8		-8		-8		8
*V_D = -7.82			-16	397			-16	-366											-16	-16			16	16								
*V_H = -5.47			-11	-256			-11	536				-258							-11	-11			11	11								
V_M = -3.27								-154			-7	320			-7	-153											-7	-7			7	7
*V_Q = -1.56											-3	-73			-3	79											-3	-3			3	3
U_A = 1.60	-3	3			-3	3											-81	75			3	3										
U_B = 1.31	-3		3		-3		3										61	-133	61		3	5	3									
U_C = .86		-2		2		-2		2										40	-87	40		2	3	2								
U_D = .71			-1	1			-1	1											33	-36			1	1								

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}.

TABLE 19. COMPLETE CHECK TABLE FOR MODEL WITH DOUBLE CUTOUT.

* ADJUSTED VALUES APPEAR AT END OF TABLE. SHEET 2.

DISPL.	Y_A	Y_B	Y_C	Y_D	Y_E	Y_F	Y_G	Y_H	Y_J	Y_K	Y_L	Y_M	Y_N	Y_O	Y_P	Y_Q	X_A	X_B	X_C	X_D	X_E	X_F	X_G	X_H	X_J	X_K	X_L	X_M	X_N	X_O	X_P	X_Q
U_E = 1.32	3	-3							-3	3							3	3			-74	63			3	3						
*U_F = 1.59	3		-3			3	-3		-3	3							3	6	3		76	-169	74		3	3						
U_G = 2.09		4		-4		4		-4										4	8	4		98	-212	98								
U_H = 2.25			5	-5			5	-5											5	5			105	-114								
U_J = -.36					-1	1							1	-1							-1	-1			20	-17			-1	-1		
U_K = -.47					-1	1				1	-1		1		-1						-1	-1			-22	50	-22		-1	-2	-1	
U_L = -.96										2		-2		2		-2										-45	98	-45		-2	-4	-2
U_M = -1.35											3	-3			3	-3											-63	69			-3	-3
U_N = -.28									-1	1			-1	1											-1	-1			14	-13		
U_O = -.13																										-1			-6	13	-6	
U_P = .40										1		-1		1		-1										1	2	1		19	-41	19
U_Q = .77											2	-2			2	-2											2	2			36	-39
RESIDUAL	0	-1	-1	-1	1	-2	-3	-2	-2	3	2	-5	-3	5	3	-6	3	1	-3	-2	1	6	0	2	0	-2	1	3	-3	-3	-3	-1
*U_F = 1.61	3		-3			3	-3		-3	3							3	6	3		77	-172	75		3	3						
*V_F = -.04			-2			4				-2																						
*V_O = 2.18									4	107	4		4	-125	4										4		-4		-4		4	
*V_D = -7.78			-16	395			-16	-364											-16	-16			16	16								
*V_H = -5.44			-11	-255			-11	533				-256							-11	-11			11	11								
*V_Q = -1.59											-3	-74			-3	81											-3	-3			3	3
FINAL RESIDUAL FORCES	0	-1	-3	-2	1	2	-3	-3	-2	2	2	-4	-3	3	3	-4	3	1	-3	-2	2	3	1	2	0	-2	1	3	-3	-3	-3	-1

FORCES IN LB., DISPLACEMENTS IN IN. X 10^{-4}

TABLE 20. STRESS CALCULATIONS FOR MODEL WITH DOUBLE CUTOUT.

CALCULATION OF STRESSES IN VERTICAL STRINGERS.

MEMBER mn	$V_{m\,TOT} \times 10^4$ IN.	$V_{n\,TOT} \times 10^4$ IN.	$(V_{n\,TOT} - V_{m\,TOT})10^4$	$K \times 10^{-4}$ $\frac{LB.}{IN.^2}$/IN.	STRESS PSI.
AE	-5.45	-3.25	2.20	375	825
DH	-7.78	-5.44	2.34	"	878
EJ	-3.25	-1.43	1.82	"	683
HM	-5.44	-3.27	2.17	"	814
JN	-1.43	.09	1.52	"	570
MQ	-3.27	-1.59	1.68	"	630
BF	-.48	-.04	.44	"	165
CG	-2.77	-2.75	.02	"	8
FK	-.04	1.05	1.09	"	409
KO	1.05	2.18	1.13	"	424
LP	3.22	3.79	.57	"	214

CALCULATION OF STRESSES IN HORIZONTAL STRIPS

MEMBER mn	$U_{m\,TOT} \times 10^4$ IN.	$U_{n\,TOT} \times 10^4$ IN.	$(U_{n\,TOT} - U_{m\,TOT})10^4$	$K \times 10^{-4}$ $\frac{LB.}{IN.^2}$/IN.	STRESS PSI.
AB	1.60	1.31	-.29	375	-109
BC	1.31	.86	-.45	"	-169
CD	.86	.71	-.15	"	-56
EF	1.32	1.61	.29	"	109
FG	1.61	2.09	.48	"	180
GH	2.09	2.25	.16	"	60
JK	-.36	-.47	-.11	"	-41
KL	-.47	-.96	-.49	"	-184
LM	-.96	-1.35	-.39	"	-146
NO	-.28	-.13	.15	"	56
OP	-.13	.40	.53	"	199
PQ	.40	.77	.37	"	139

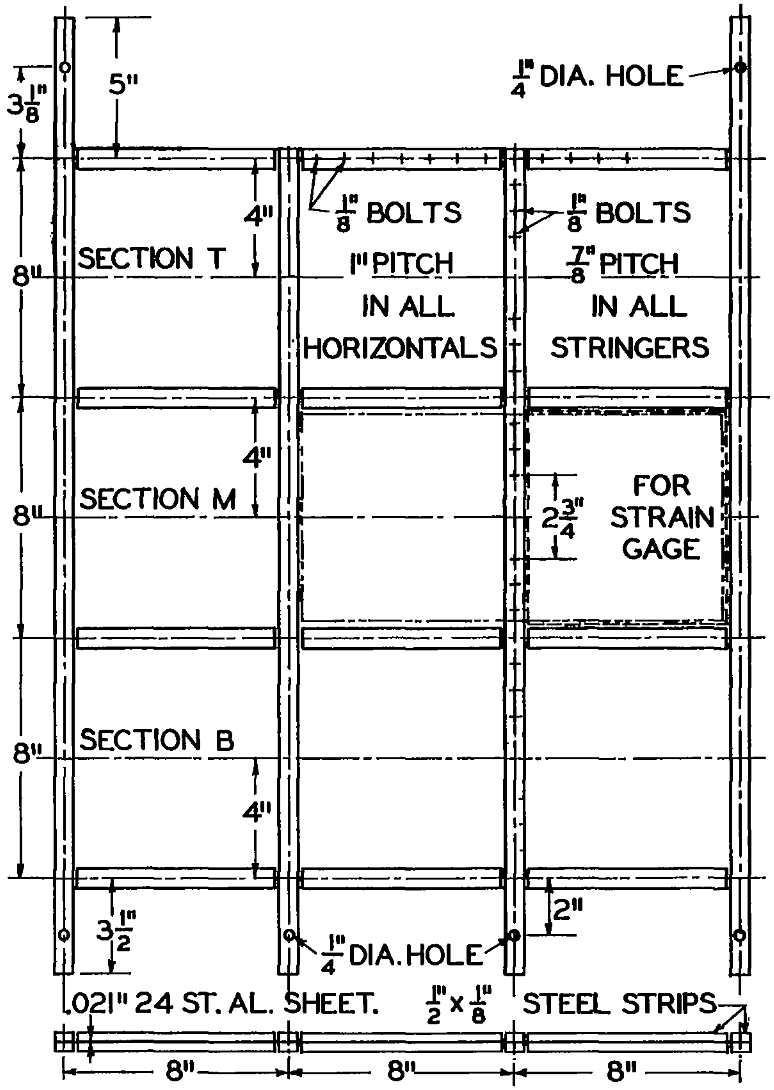

FIG. 1. MODEL TESTED.

- - - - - - - LOCATION OF SINGLE CUTOUT.

——————— LOCATION OF DOUBLE CUTOUT.

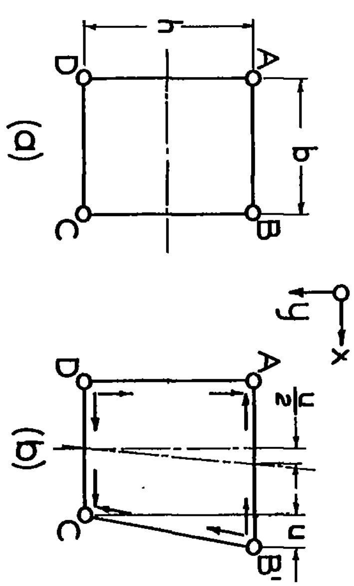

FIG. 4. UNIT OF REINFORCED SHEET.

ARROWS INDICATE DIRECTION OF SHEARING FORCES TRANSMITTED FROM SHEET TO CONSTRAINTS.

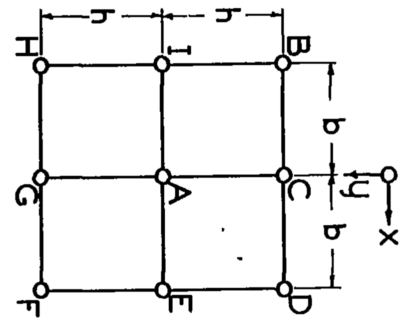

FIG. 5. FOUR PANEL SYSTEM.

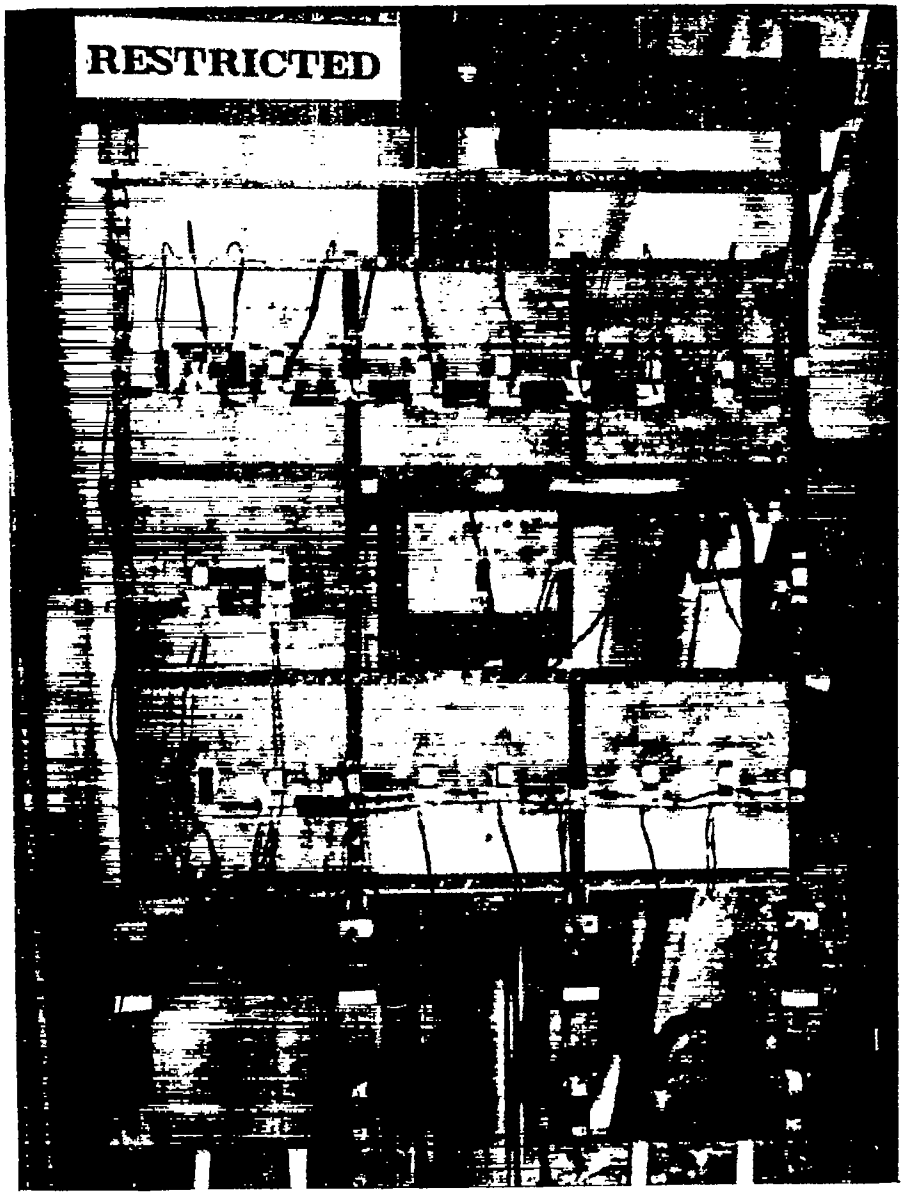

Figure 2.- Front view of test setup.

Figure 3.- Three-quarter view of test setup.

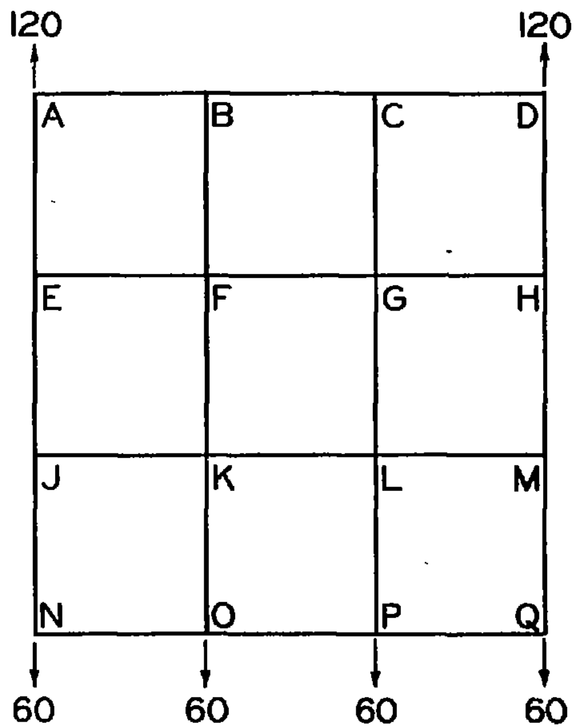

FIG. 6. SCHEMATIC DRAWING OF MODEL WITHOUT CUTOUT.

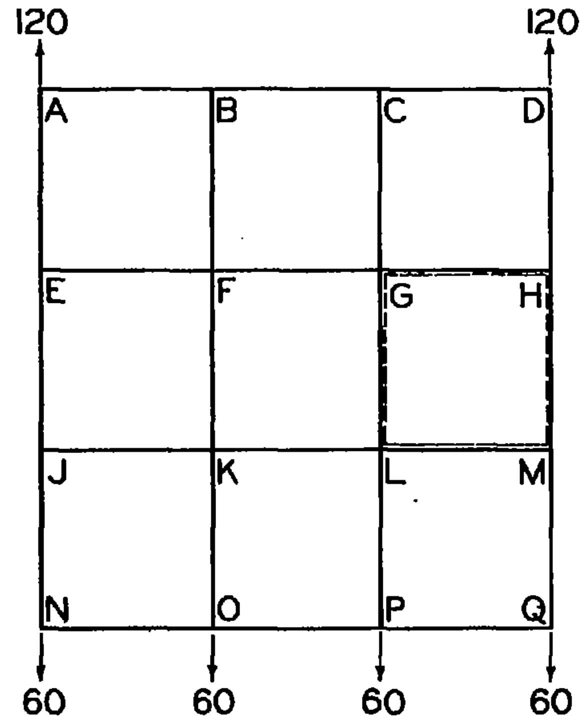

FIG. 7. SCHEMATIC DRAWING OF MODEL WITH SINGLE CUTOUT.
------ LOCATION OF CUTOUT.

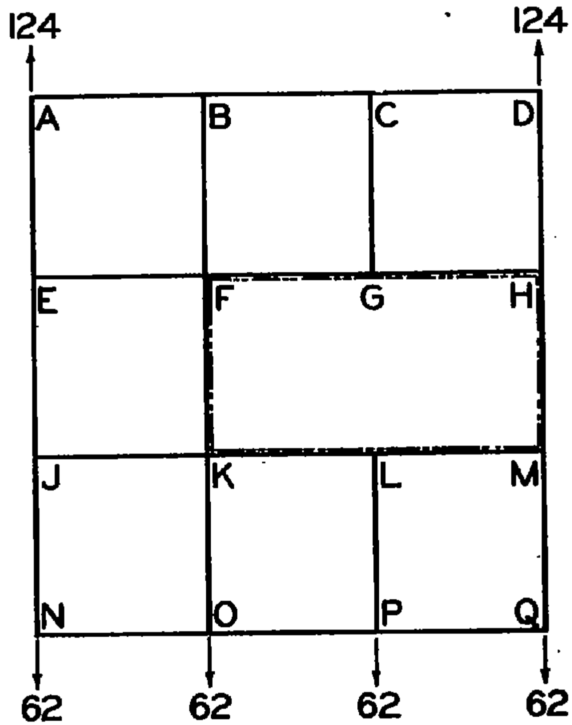

FIG. 8. SCHEMATIC DRAWING OF MODEL WITH DOUBLE CUTOUT.
----------- LOCATION OF CUTOUT.

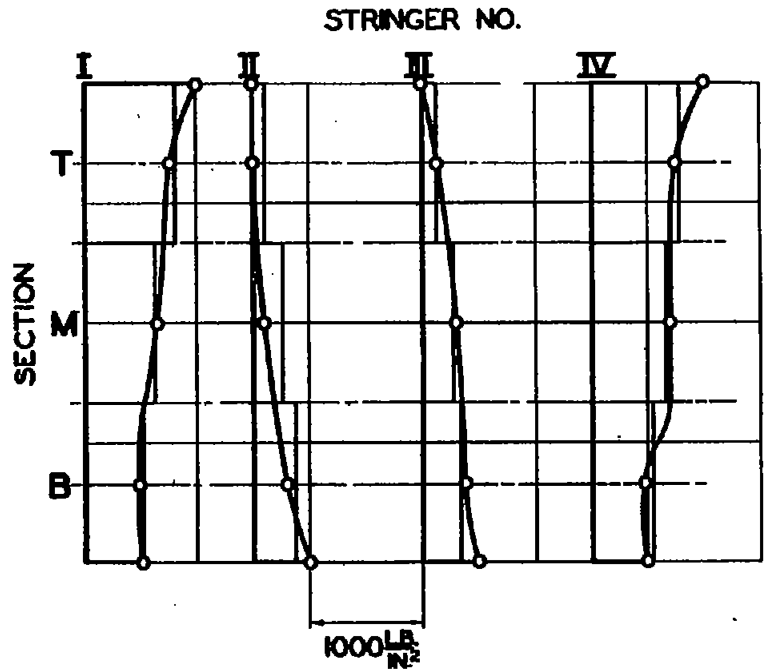

FIG. 9. CALCULATED AND MEASURED DIRECT STRESS IN STRINGERS FOR MODEL WITH SINGLE CUTOUT.
o MEASURED VALUES
——— CALCULATED VALUES.

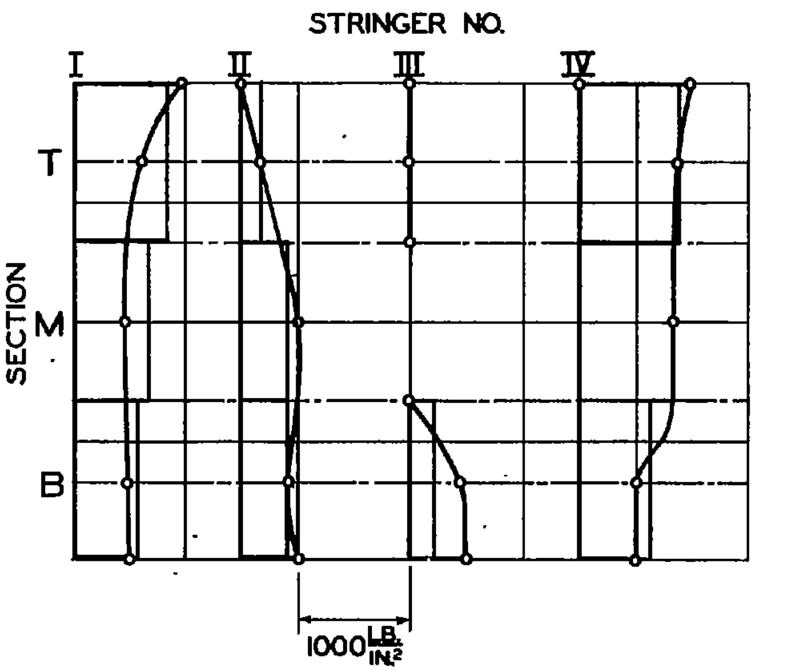

FIG. 10. CALCULATED AND MEASURED DIRECT STRESS IN STRINGERS FOR MODEL WITH DOUBLE CUTOUT.

o MEASURED VALUES.

—— CALCULATED VALUES.

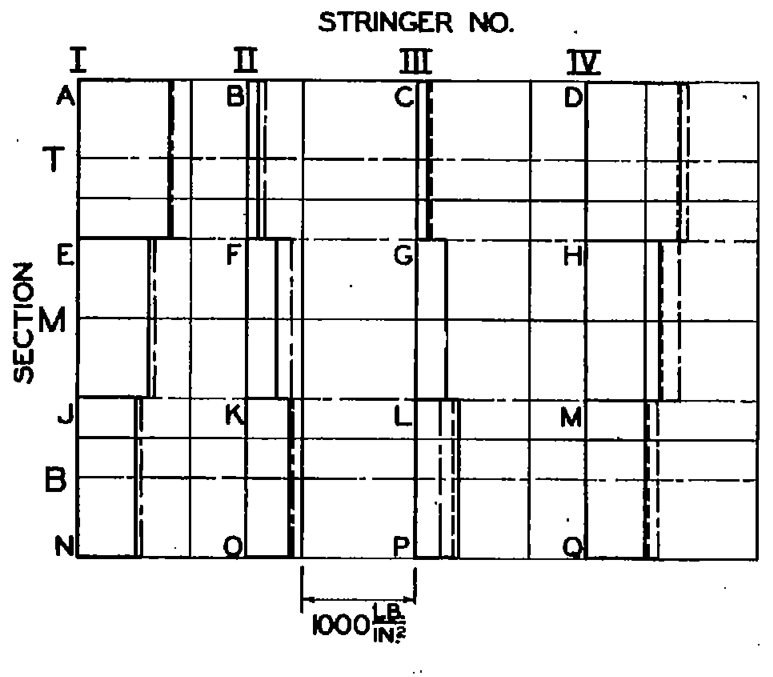

FIG. 11. COMPARISON OF CALCULATED DIRECT STRESS IN STRINGERS FOR THE THREE MODEL CONDITIONS.

—— FOR MODEL WITH NO CUTOUT.

– – – FOR MODEL WITH SINGLE CUTOUT.

–·–·– FOR MODEL WITH DOUBLE CUTOUT.

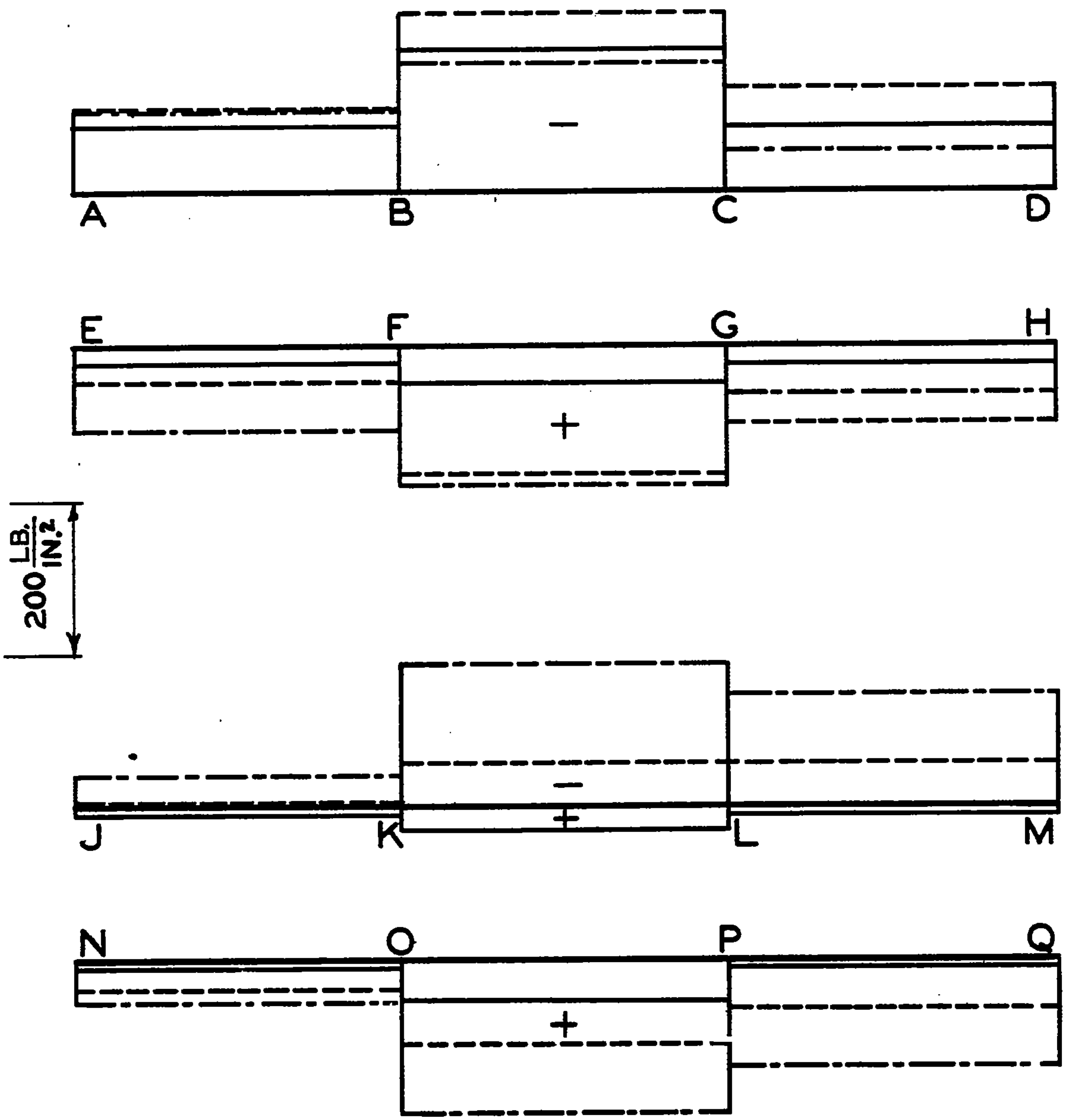

FIG. 12. COMPARISON OF CALCULATED DIRECT STRESS IN HORIZONTAL STRIPS FOR THE THREE MODEL CONDITIONS.

——————— FOR MODEL WITH NO CUTOUT.

– – – – – – FOR MODEL WITH SINGLE CUTOUT.

—·—·—·— FOR MODEL WITH DOUBLE CUTOUT.